# AVIATION
## AND
## AERONAUTICAL ENGINEERING

(C) Kadel & Herbert — French Airplane Over Shell Holed Ground

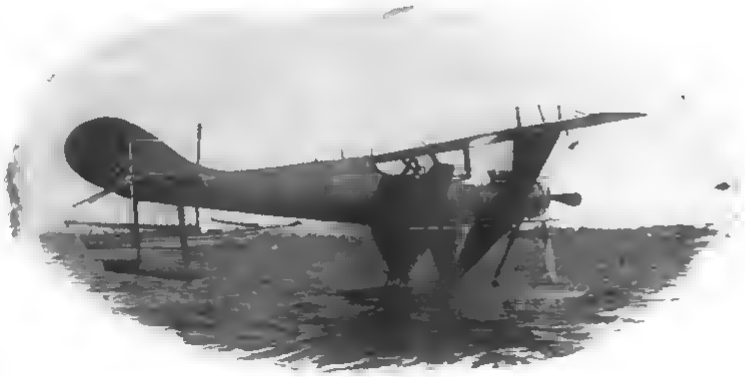
VOLUME III
Number 10

PRICE
Fifteen
Cents

SPECIAL FEATURES

A MODERN ZEPPELIN AIRSHIP
STEEL IN AIRPLANE CONSTRUCTION
TWO AUSTRO-HUNGARIAN SEAPLANES
KILN DRYING AIRPLANE WOODS
INTERNATIONAL AIRCRAFT STANDARDS

PUBLISHED SEMI-MONTHLY
BY
THE GARDNER-MOFFAT CO., Inc.
120 W. 32nd ST. NEW YORK



CONTRACTORS TO

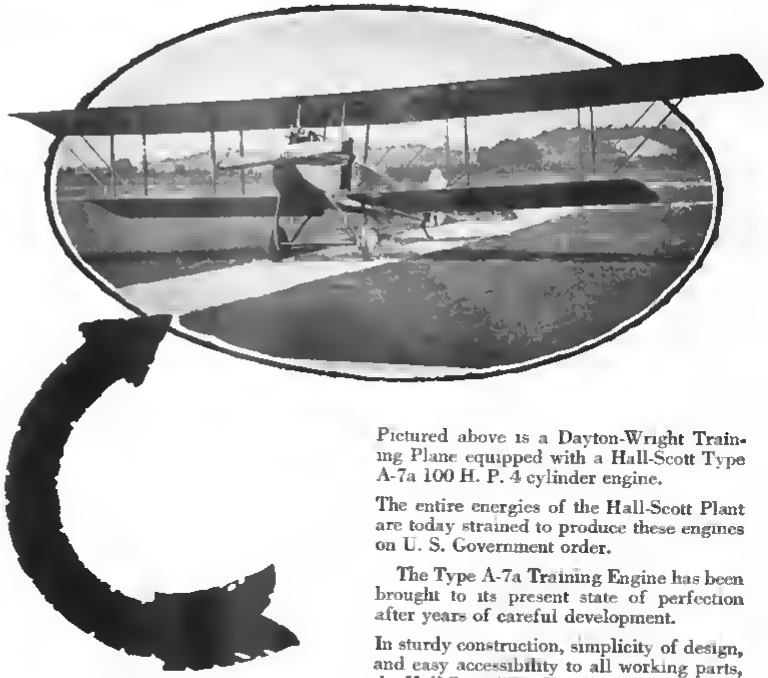
The United States Army and Navy
The British Admiralty

# THE BURGESS COMPANY

MARBLEHEAD, MASS.

*Sole Licensees for the United States for the Dunne Potents*





Pictured above is a Dayton-Wright Training Plane equipped with a Hall-Scott Type A-7a 100 H. P. 4 cylinder engine.

The entire energies of the Hall-Scott Plant are today strained to produce these engines on U. S. Government order.

The Type A-7a Training Engine has been brought to its present state of perfection after years of careful development.

In sturdy construction, simplicity of design, and easy accessibility to all working parts, the Hall-Scott "Big Four" stands supreme.

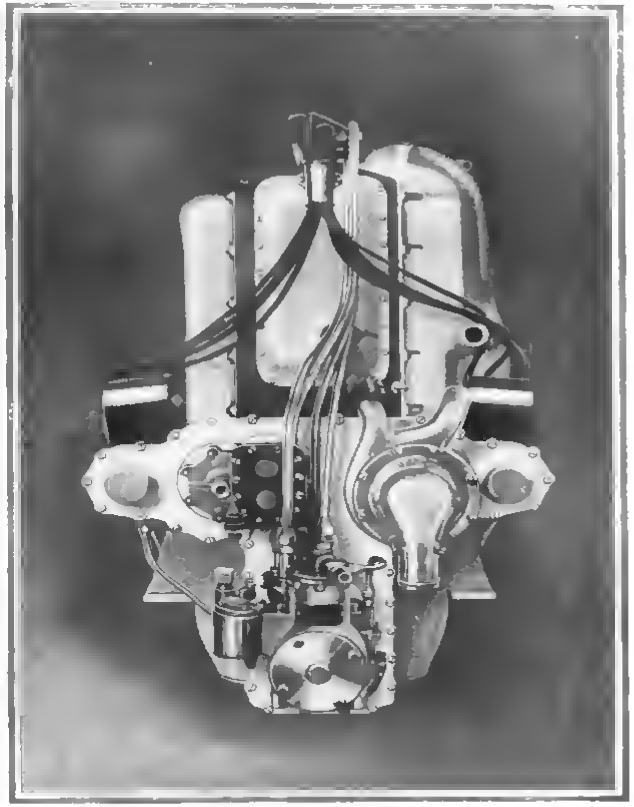
*Hall-Scott Motor Car Company*

CROCKER BUILDING, SAN FRANCISCO, CALIFORNIA

*Eastern Representative*

F. P. WHITAKER, 165 Broadway, New York City

HALL-SCOTT



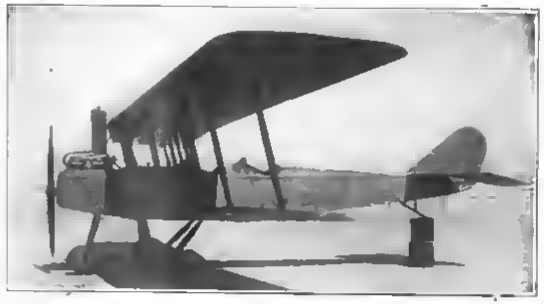
## New Duesenberg Airplane Engi

Four cylinder, sixteen valve, 4¾" x 7", driving propeller thr
a reduction gear. Equipt with a Christensen Air Starter, and
magnetos.

125 H.P. guaranteed at 1400 R.P.M. of propeller and
R.P.M. of engine. Actually develops 140 H.P. Weight, com
with equipment as illustrated, 470 lbs. Can also be supplied
out reduction gear to deliver 100 H.P. at 1400 R.P.M.
speed. Weighing 425 lbs.

**DUESENBERG MOTORS CORPORATI**
**120 BROADWAY** **NEW YORK**





AERO STANDARD CORPORATION

Factories, Plainfield, N. J., Elizabeth, N. J.
Executive offices, Woolworth Bldg.
New York City

# STANDARD

# NEW ENDURANCE RECORD

*Established by*

*Union Airplane Motor at U. S. Aeronautical Testing Laboratory, Navy Yard, Washington, D. C.*

*Best previous record exceeded by fifty per cent.*

**UNION GAS ENGINE COMPANY**

ESTABLISHED 1885

**OAKLAND - - - CALIFORNIA**

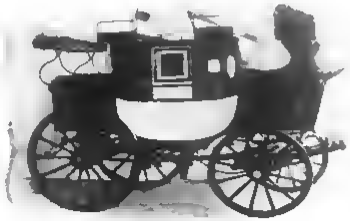


·L·W·F· ENGINEERING·COMPANY·

COLLEGE POINT, N. Y.

# WM. HARLAND & SON

ESTABLISHED 1791

## HARLAND'S VARNISH

has been the Standard of Quality from the old coach days, through the automobile period, to the airplane of today

## HARLAND'S VARNISH

has been "over the top" in France for more than three years on Allied airplanes—British, French and Italian

## WM. HARLAND & SON

MERTON, ENGLAND
TORONTO, CANADA
BUFFALO, N. Y.



# SKF

## The Airplane and Its Bearings

No matter how carefully the manufacture of airplanes is controlled, there are bound to be slight warpage and mis-alignment in the propeller shafts which produce inaccurate seats and housings for the bearings, so that undue binding strains are introduced in rigid bearings.

The ability of SKF to automatically compensate for any mis-alignment eliminates wear and permits of efficient operation of rotating parts. For safety's sake use Self-aligning Ball Bearings marked SKF Getting the wrong type of bearing may be serious

**SKF BALL BEARING CO.**

HARTFORD 230 CONN.

BALL SKF BEARINGS

# The J. G. White Engineering Corporation

*Designers* *Engineers*

*Contractors*

Perform all designing, engineering and construction work in connection with aeroplane factories; aviation fields; also other industrial properties and public utilities.

Engineering investigations and reports made with recommendations covering every detail of design and construction.

Purchase for clients apparatus, materials and supplies of every description, and make necessary inspections and arrangements for prompt shipment.

**43 Exchange Place - New York**

LONDON CHICAGO



## CRANKSHAFT QUALITY

Stands out as the one requirement today of the builder of

### AIRCRAFT AND HIGH DUTY ENGINES

Experience only can produce a product to equal these demands.

Wyman-Gordon Company for many years, in their Research, as well as their Manufacturing Departments, have been developing along the lines that make them today able, without experiment, to supply crankshafts of

### UNQUESTIONED RELIABILITY

Every stage in the production of a Wyman-Gordon crankshaft is subjected to rigid inspection and tests guaranteeing a high metallurgical quality.

Behind this perfect product is a perfect service.

Prompt attention to all orders and deliveries without delay

## WYMAN-GORDON COMPANY

WORCESTER, MASS.


BOYCE
MOTO METER
MODEL "C" FOR AIRPLANE SERVICE
READY FOR DELIVERY DECEMBER 1ST
$30.00
THE MOTO-METER COMPA
LONG ISLAND CITY NEW YO
Creators of Motor Heat Indica
Exclusive Licensee of Boyce Fundamenta
Patents




AEROIL
practical quality oil
for aeroplane motors
SWAN

## Lynite Engineers Will Help Solve Your Problems

If you are doing experimental work in the airplane field, the wide experience of Lynite engineers should be of value to you. It is always at your disposal.

These engineers, who have long been in constant touch with the aviation situation, have an understanding of airplane requirements such as can be obtained only through close contact.

Their assistance has been appreciated by a number of airplane and engine builders, including Curtiss, Hall Scott Thomas-Morse, Duesenberg and Kessler, all of whom are extensive users of Lynite

LYNITE



# The Survival of the Swiftest

A little more power, a little less weight in the engine—and another combat in the skies has been won. Mastery of the air—that prize of prizes—today belongs to the swiftest.

In helping American builders to produce airplanes that will insure to the Allies supremacy in the skies, *Lynite* is playing a notable part.

For through *Lynite*, the airplane-maker has found a better way to more speed, both by lessening weight and by increasing engine capacity.

The remarkable lightness, strength and heat-conductivity of *Lynite* Alloys have led to their use by a large number of builders and for a large number of parts, including such vital ones as cylinder-castings and pistons.

A partial list of other airplane-engine parts now being made of *Lynite* embraces crank-cases, oil-pans, gear-housings, pumps and pump-covers, cam-shaft housings, rocker-arm covers, elbows, breather pipes and caps, hot-air pans and others. In fact, on one famous airplane-engine there are 54 different *Lynite* parts.

*We also make LYNUX Bronze Bushings and Bearings, including bronze-back babbitt-lined bearings. For further information address Dept 140 Cleveland*

**THE ALUMINUM CASTINGS COMPANY**

*LYNITE and LYNUX Castings*

Cleveland Detroit Buffalo Manitowoc, Wis. Fairfield, Conn.

LYNITE

DECEMBER 15, 1917 **AVIATION** AND AERONAUTICAL ENGINEERING VOL. III. NO. 10

*Member of the Associated Business Papers, Inc*


*INDEX TO CONTENTS*




THE GARDNER, MOFFAT COMPANY, Inc., *Publishers*
120 WEST 32D STREET NEW YORK
WASHINGTON OFFICE, 908-10 EVENING STAR BUILDING

SUBSCRIPTION PRICE: TWO DOLLARS PER YEAR. SINGLE COPIES FIFTEEN CENTS. CANADA AND FOREIGN: TWO DOLLARS AND A HALF A YEAR.



ISSUED ON THE FIRST AND FIFTEENTH OF EACH MONTH FORMS CLOSE FIVE DAYS PREVIOUSLY. ENTERED AS SECOND-CLASS MATTER, AUGUST 3, 1916, AT THE POST OFFICE AT NEW YORK, N. Y., UNDER ACT OF MARCH 3, 1879.

W. [illegible] MUFFA
PRESIDENT
A. SEAMAN
TREASURER
ROBERT BROWN
SECRETARY

# AVIATION AND AERONAUTICAL ENGINEERING

H. M. WILLIAMS
MANAGING EDITOR
LADISLAS d'ORCEY
ASSOCIATE EDITOR
GEORGE NEWBOLD
BUSINESS MANAGER

Vol. III December 15, 1917 No. 10

## The Modern Zeppelin Airship

By Ladislas d'Orcey, M.S.A.E.

The capture, by French aviators, of the German naval airship L-49 on Oct. 20, at Bourbonne-les-Bains, has lifted the veil of secrecy which surrounded the constructional details of Zeppelin airships since the outbreak of the war. The L-33, which was brought down by British aviators a year ago in Essex, already gave certain indications of the improvements embodied during three years of warfare, but as the vessel was burned by its crew these indications were necessarily incomplete. The complete state of preservation of the L-49 now, happily, supplements our knowledge of the latest German practice in rigid airship construction, for, although this airship is a greatly perfected L-33, both vessels may be regarded as belonging to virtually the same, so-called super-Zeppelin class.

*General Considerations*—The most striking points in the new Zeppelin model are its dimensions, its shape, and the arrangement of the propelling apparatus. The overall length has grown from 158 m., of the *ante bellum* airship L-3, to 196 m. 00 the L-49; the master diameter has increased, in a much greater proportion, from 16.60 m. to 25 m., with the result that the fineness ratio has gone back from 9.5 to 7.8. This leads us at once to consider the stream-line of the new ships. The cross-section is now a 25-sided polygon, instead of a 17-sided one, thus approaching the ideal circular cross-section; the nose is much blunter than heretofore, while the stern tapers to a distinctly conical end. This shape, taken in conjunction with the decreased fineness ratio, insures a better flow of the air filaments along the hull and greatly reduces frictional resistance. This is also cut down materially in so far as the keel is now built into the hull instead of protruding therefrom, while the cars are carefully stream-lined and only carry pusher airscrews. The elaborate staying of airscrews by means of outriggers on either side of the hull, which in part still survived on the L-33, is thus dispensed with. Finally, the steering-gear is of simple, cruciform design, consisting of symmetrically shaped horizontal and vertical fins and rudders, instead of the high resistance multiplane control surfaces of early Zeppelins. All of this obviously results in a material saving of head resistance, in other words, greater speed can be attained with equal motive power. Such are, briefly, the most striking external improvements found on the super-Zeppelin. Internally, the Zeppelin has surely been improved as much as externally, the constructional details involved in the internal arrangement, which are not, generally, visible in the accompanying illustrations, will for this reason now be discussed at some length.

STARBOARD POWER CAR OF THE L-49. NOTE RADIATOR HOIST FOR VARYING AREA OF COOLING SURFACE
(C) *Underwood & Underwood*

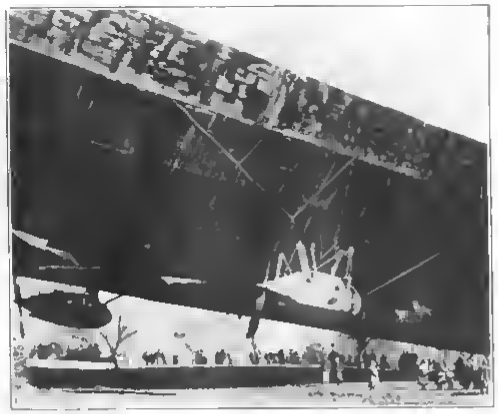
*The Hull*—The hull is built up, as heretofore, of duralumin lattice girders of triangular cross-section, there being twenty-five longitudinals and thirty-six polygonals, not counting minor fairing elements occurring at the nose and at the stern. These girders are built up of three corner rails of channel section, which are inter-connected by X-pieces of fluted section, the cross-section of the girders is an isoceles triangle measuring 0.27 m. in height and 0.14 m. at the base. The thickness of the metal varies from 0.5 to 1.0 mm., according to the strength required by the function; the strongest girders weigh approximately 1 kg. per meter length, and have a tensile strength estimated at from 28 to 40 kg. per sq. mm.

The joining of longitudinals and polygonals, which intersect one another at right angles, is rather difficult to explain, in writing, with sufficient clearness. For a clear comprehension it should be noted before all that while the cross-section of the hull is a twenty-five-sided polygon, one half of the longitudinals serve but as fairing elements, so that the *structure de force* of the hull is actually a thirteen-sided polygon. There are then thirteen main longitudinals, which run at the angles of the transverse girders forming the main polygons, while intermediate longitudinals are carried in the middle of and upon the outer side of the transverse girders. The bottom side of the main polygon does not, however, carry an intermediate longitudinal, this in order not to weaken the keel, which occurs at this place. Every second transverse girder is internally braced up by a king post truss, an extension of which is carried through the girder and serves as a head for the intermediate longitudinals.

The keel, which now runs within the hull, is formed, as has been said before, of two main longitudinals, forming its base, and of an additional internal longitudinal, situated 3 m. above and in the center line of the base, thus forming a cross-sec-

Nose of the L-49. A Gas Valve is Visible on the Upper Right-Hand Side
(C) Underwood & Underwood

tion like the letter A. This triangular structure is stiffened transversely by cross members corresponding to the cross-bar of the letter A, and longitudinally by longitudinal girders occurring at the height of the cross bars. The apex of the keel is furthermore joined to the transverse girders of the hull by horizontal girders, of which there appear, however, to be only a limited number. The internal longitudinal which forms the apex of the keel is not carried through the whole length of the ship, but apparently stops in the neighborhood of the forward and after cars. Nor are the main and intermediate longitudinals carried through, for all stop at the first and last polygonal girders, at the nose only the apex rail of the longi-



Midship Section of the L-49, Showing Relative Position of Power Cars
(C) Underwood & Underwood

tudinals continues beyond the first transverse frame, the rails meeting in a nose ring. Here again the principle of the *structure de force* is emphasized in that the outer rails of the main longitudinals run through to the extreme end of the hull, whereas those of the intermediate girders stop further inward. The construction of the stern is similar to that of the nose.

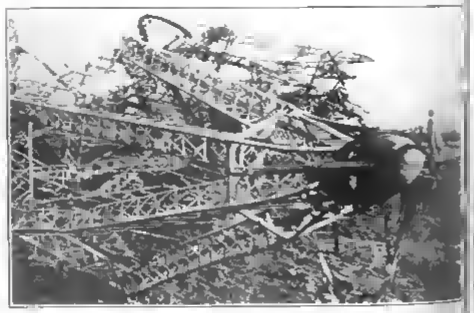
The control surfaces are duralumin frames, which are built up in a way similar to the hull girders, except that their cross-section is rectangular and has much smaller proportions. Rudders and elevators are balanced at about one-third chord length from the leading edge, to facilitate manual control. The cam-

Stern View of the L-49
Photo Pictorial Press

ful streamlining of these airships extends to the very control arms of the mobile surfaces, which are quadrant shaped. The control cable runs in a groove provided on the periphery of the quadrants. The lower vertical fin is protected by a streamlined skid.

The truss of the hull is of the conventional type, the panels formed by the intersection of longitudinals and transverse girders being braced by diagonal stays, while the athwartship truss consists mainly of radial wires running from the angles of the main polygons to a central hub. There appears to be, in addition, a special truss which transmits the weight of the keel to some of the upper longitudinals, that is, to the region of maximum lift.

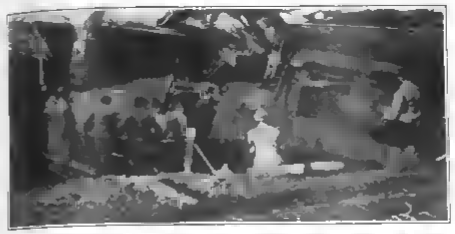
The outer cover of the hull is made of linen fabric, which on the lower half is dyed a brilliant black by means of a coal-



Girder Work of the Stern of the L-44, in the Building Ground, an Elevator Frame
Photo Pictorial Press

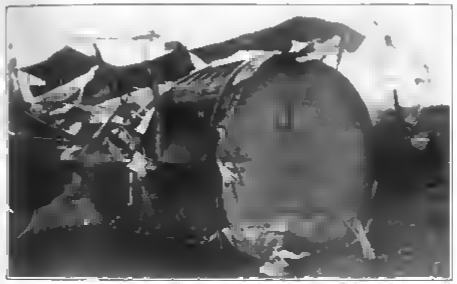
tar dope, while the upper half is painted cloud gray. The camouflage answers the purpose of misleading aviators who may be at a higher level than the airship, while any detection from the ground is rendered very difficult at night, since the black underside does not reflect the rays of searchlights. The last, "invisible," rail on London seems to bear out the word of this color scheme. The outer cover is laced in sections over the framework, an arrangement which facilitates inspection of the gas cells when the airship is berthed in its shed.





The Forward Car of the L-31 Being Taken Down by French Sappers
(C) Underwood & Underwood

*The Gas Bags*.—The gas bags, numbering nineteen on the L-33 and eighteen on the L-49, are made of cotton fabric internally lined with goldbeaters' skin, and not, as prior to the war, of rubberized fabric. The use of goldbeaters skin, which



Front Compartment of the Forward Car After It Separation from the Rear Compartment
(C) Underwood & Underwood

some writers have only attributed to Germany's rubber shortage, affords much greater gas tightness, some 95 per cent in twenty-four hours, as against one half to one per cent for rubberized fabric!—and while its high cost is much against it in time of war, its only real drawback is low tensile strength, which prevents the gas from being stored at anything above atmospheric pressure. The reinforcement of this material by cotton fabric is, therefore, a considerable improvement over *ante-bellum* practice, and explains why the Germans have been

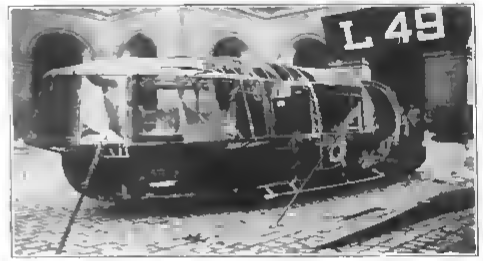
Engine Compartment of the Forward Car
(C) Underwood & Underwood

able to provide some of the gas bags of the L-49 with a compensating ballonnet.

Although in a rigid airship the shape of the hull is not dependent upon internal pressure, the use of the ballonnet may have several advantages. Thus, when the gas bags are not taut, the ballonnet permits to compress the gas so it will apply

Close View of the Engine Installation
(C) Underwood & Underwood

its lift upon the upper portion of the hull instead of surging about and displacing the center of buoyancy, which naturally alters the trim. On the other hand, by keeping the gas bags taut, the danger of self-electrification is lessened to a great extent, for rubberized fabric emits sparks when it is creased in any way. This danger is not to be feared with goldbeaters' skin. Finally, losses of gas due to variations of atmospheric pressure and temperature are greatly lessened with the use of




Forward Car of the L-49, Exhibited at Napoleon's Tomb
(C) Kadel & Herbert

the new Zeppelin fabric, because if the gas bags are filled at sea level at the atmospheric pressure, the gas may be permitted to expand, upon reaching higher regions, up to the safety factor of the fabric before being expelled by the automatic valves.

A strong but light ramie netting, which is trussed to the framework, surrounds each gas bag and prevents it from either chafing against the hull or bulging into the keel. The gas bags are roughly drum-shaped, except for a portion which is cut

nut at the bottom to furnish sufficient clearance for the keel

Each gas bag is provided with a spring loaded safety valve, which opens into a vertical, ventilating shaft running to the top of the hull Each two adjoining gas bags have a common ventilating shaft, consisting of a wire armature this is why

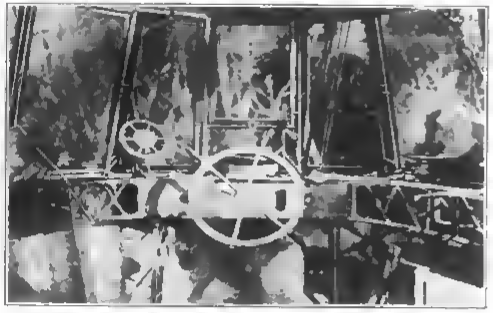


CHART ROOM OF THE L-49 NOTE BOMB SIGHT ON THE RIGHT
*Photo Central News Photo Service*

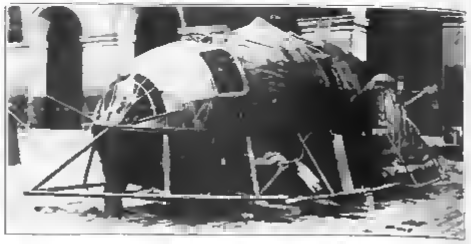
the radial truss occurs only at every second transverse girder The forward and after gas bags have in addition to the safety valve a maneuver valve, which is lacking in the gas bags of the midship portion, in order not to decrease the lift where it is most needed

*The Cars*—The L-33, as well as the L-49, each had four cars, mounted crosswise in such fashion that the forward and after cars were situated in the centerline of the ship, while the two remaining cars were mounted about amidships, on a common transverse axis, on either side of the hull The midship cars serve exclusively as engine rooms, each housing a 240 hp Maybach engine, which drives through a clutch and speed change transmission a pusher screw of 5 m diameter The power plant of the forward car is identical, while that of the after car consists of two Maybach engines, which may be coupled to a single pusher screw either separately or simul-

ELEVATOR WHEEL IN THE CHART ROOM
(C) *Underwood & Underwood*

taneously, according to needs of speeding up or slowing down

The forward car is subdivided into a chart room and an engine room, which are structurally separate parts, being united only by an outer casing of fabric This structural separation is due to the necessity of preventing the vibrations of the engine being transmitted to the radio cabin, which is situated in the after part of the chart room The latter is very spacious, measuring 6 m. in length, 2 50 m in height and 2 25 m in width, the engine room is 4.50 m long The chart room



FRONT VIEW OF A POWER CAR
(C) *Kadel & Herbert*

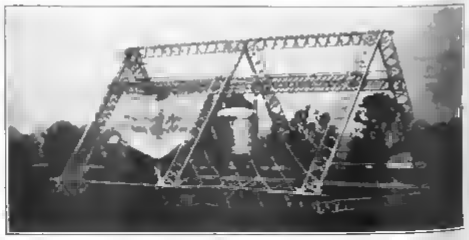
is provided with large mica hay windows, and contains all the control gears, such as rudder and elevator wheels, valve and ballast lines, engine telegraphs, gas pressure and temperature indicators, as well as the usual navigating instruments. The bomb sight and the electric bomb release mechanism are also located in the chart room

The cars are built up of a light duralumin framework, which is covered on the lower hull with corrugated sheet aluminum, while the upper half is covered with fireproofed fabric They

REAR VIEW OF A POWER CAR IN THE BACKGROUND A KING-POST GIRDER
(C) *Kadel & Herbert*

are connected to the hull by means of hollow wooden struts and cables.

*Internal Equipment*—The four cars are connected with one another by means of a narrow gangway running in the middle of the keel, from which access is afforded to the cars by suitable ladders The observation platform which is provided atop of the hull can also be reached from the keel. For the purpose a climbing tube consisting of a wire armature covered with fabric, and containing an aluminum ladder, is fitted amidships between two gas bags An additional lookout post, situated at the stern, aft of the rudders, is reached in the same way. These platforms were devoid of any armament on the L-49, the L-33, however, mounted two Maxims forward and

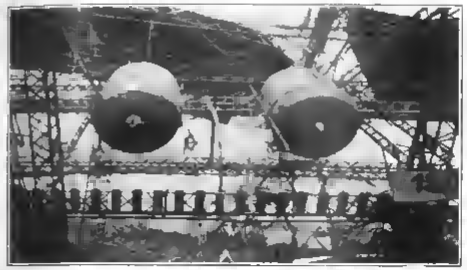


PORTION OF THE KEEL, WITH A FUEL TANK AND A BALLAST BAG HUNG FROM THE BACK RAIL
(C) *Kadel & Herbert*



one aft, and had, in addition, six machine rifles mounted on the cars.

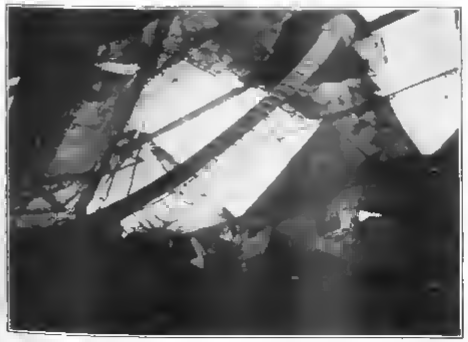
All the mobile weights of the Zeppelin, such as fuel tanks, water ballast bags and bombs, are distributed in the keel. All of these were suspended, in the L-49, on the longitudinal girders running at the height of the cross members, above referred to The fuel tanks are aluminum cylinders of 300 liters capacity, while the water ballast is carried in bags of 1,000 liters capacity, hand lines, leading to the chart room, controlling the release valves. To prevent freezing, the water ballast is mixed with alcohol A noteworthy feature of the L-49 was



THE GANGWAY AS SEEN FROM BELOW. NOTE NETTING OVER THE KEEL
(C) *Underwood & Underwood*

the liberal use of trap doors through which all mobile weights may be dropped in case of emergency, such gasoline tank, ballast bag and bomb being provided with its individual trap door. No electric wiring is found in the keel except that required by the bomb gear, all internal lighting being insured by radium compound knobs All inscriptions relative to gas bags, fuel tanks, etc, are similarly indicated by night. On either side of the gangway hammocks are suspended for the crew

*Apportionment of Weights*—Although detailed information from abroad is still lacking, the weight of sufficient items is known, so one may figure out with tolerable accuracy how the weights were apportioned in the L-49. The weight per meter length of the girders forming the hull proper being 1 kg., and the length of the vessel being approximately 200 m., twenty-five longitudinals will weigh about 5 tons Thirty-six transverse girders of about 80 m circumference weigh roughly 3 tons. The total area of the outer cover is estimated at 10,000 sq m., which, at 200 g per sq m of fabric (such as used in



CLIMBING TUBE, LEADING TO THE AFTER PLATFORM ON TOP OF THE HULL
(C) *Underwood & Underwood*

the outer cover of early Zeppelins) puts the weight of the outer cover at 2 6 tons. A similar computation for the goldbeaters' skin of the gas bags, of which there are about 20,000 sq m. in all, and which weighs 170 g per sq m (according to German pre-war figures) places the total weight of the gas bags at 3 4 tons The forward and after cars weigh 2 tons each, the

THE ELEVATORS OF THE L-49
(C) *Underwood & Underwood*

midship cars 1 ton each If a further allowance of 2 tons be made for the weight of the internal girderwork and the truss, it would seem that the present estimate of weights should not miss the mark very widely It is obvious, that in discussing a machine from a 3,000 mile distance, many minor items are likely to escape one's attention; therefore, the writer desires to emphasize that this apportionment can only be approximately correct.

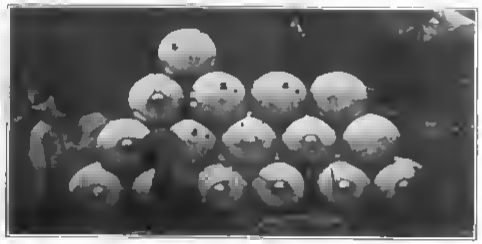
From the foregoing the gross weight of the L-49, which had a volume of 55,000 cu m., appears to be 22 tons. The total lift furnished by 55,000 cu m. of hydrogen at sea level being about 60 tons, 38 tons remain available as useful load. This figure may appear excessive, for prior to the war the useful load of Zeppelins amounted to about 30 per cent the total

WATER BALLAST BAG, COMPLETE WITH ITS FILLING APPENDIX AND RELEASE VALVE
(C) *Underwood & Underwood*

lift, while even non rigid airships have not, as yet, exceeded 50 per cent. Yet, when it is realized that an airship loses 1 per cent of its lift per 100 m ascent, and that the barograph of the L-45 (another Zeppelin brought down in France) recorded an attained level of 6,200 m., it is not difficult to guess to what use the greater portion of the Zeppelin's useful load is put.

To reach a level of 6,000 m. a 50-ton Zeppelin must lighten itself of 60 per cent of its weight, its total weight will then

amount to only 24 tons, that is 2 tons in excess of its gross weight. But in climbing to that level the Zeppelin has to carry in addition to its crew of 19, who represent a weight of 1½ tons, a sufficient fuel supply as well as a certain amount of ballast required for compensating sudden variations of lift. This would obviously be an impossible arrangement were the Zeppelin not endowed with dynamic lift. No precise figures

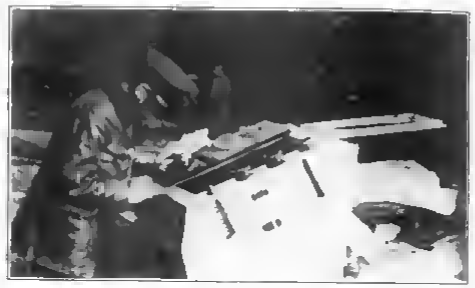


THE FUEL TANKS OF THE L-49
(C) *Underwood & Underwood*

exist on this item, though one might estimate its value, for a 60-ton Zeppelin can reach the 8,000 m level only after it has expended all of its bombs and a considerable amount of its fuel supply, always making allowance for the supplementary lift afforded by dynamic reaction. These considerations furnish conclusive evidence of the tremendous task which confronted the French aviators and anti-aircraft gunners who defeated Germany's aerial armada. It is obvious that the Zeppelins can keep at a much higher level on the homeward run than when outward bound, as by that time they have dropped their bombs and have expended a great amount of fuel. As a matter of fact several of the enemy raiders were engaged by the French defense forces at great altitude, thus the L-44 was shot down by anti-aircraft guns from a height of 5,500 m, while the L-49 was engaged by four French airplanes at the 5,300 m level.

It is true, on the other hand, that once the Zeppelin has reached its ceiling it cannot climb again to this level after it has descended to lower altitudes. This is due to the fact that ballast must be thrown not only in the ascent to compensate for the loss of lift due to expansion of hydrogen, but also in the descent when the contracted gas furnishes insufficient lift at the increased atmospheric pressure. The forced landing of the L-45, the L-50 and another Zeppelin in France must in part be attributed to these causes.

When the ground is out of sight Zeppelins steer by radio telegraphy, that is, their position is determined from two widely separated land stations by the direction from which each airship's messages are received. During the last raid the radio directions appear to have gone astray or else arrived in undecipherable shape, for according to prisoners' statements the raiders lost their bearings soon after reaching the English coast. On the return trip the low lying fog prevented the Zeppelins from noticing a strong north wind which was blowing at the high level at a speed estimated at 50 miles per hour, the airships thus drifted out of their course unawares



THE RADIO SET OF THE L-49
(C) *Underwood & Underwood*

and found themselves upon descending over what the pilots believed to be Holland, but which was really France.

Examination of the remains of the L-44, which was shot down in flames at Saint Cloud, revealed the interesting fact that this airship did not belong to the super-Zeppelin class, as did the L-45, L-49 and L-50. The L-44 had the following characteristics: Length, 177 m; diameter, 20 m; volume, 30,000 cu m, four 200 hp Mercedes engines; radius of action, 800 km; ceiling, 6,000 m; explosive load, 1,500 kg; defensive armament, four machine guns on the cars, and two on the upper platform, amidships.

# The Use of Steel in Airplane Construction

By J. M. Rogers, M.E.

The growing scarcity of the woods used in airplane construction gives rise to the consideration of other materials suitable for this purpose. In this discussion, the use of steel will be investigated and an effort will be made to remove the prejudices existing against the use of this material. In addition, the types of steel best suited for airplane construction will be taken up.

That many advantages are to be gained by replacing with steel parts of the airplane structure usually made of wood is evident from the following comparisons. In making these comparisons the following properties will be assumed:

| | Tensile Strength lb/sq in | Compressive Strength lb/sq in | Modulus of Elasticity lb/sq in | Weight lb/cu ft. |
|---|---|---|---|---|
| Spruce | 10,000 | 5,000 | 1,300,000 | 30 |
| Ash | 16,000 | 6,000 | 1,600,000 | 4 |
| Steel | | | 30,000,000 | 488 |

Comparing the moduli of elasticity of these materials, weight for weight, steel has a modulus of 1.23 times that of spruce and 1.63 times that of ash. It is therefore evident that struts of large slenderness ratio, to which Euler's formula applies, can be made lighter of steel than of wood, providing the same outer dimensions of section are maintained.

Steel, to compare favorably, weight for weight, with spruce and ash in direct compression, would have to have compressive strengths of 73,000 and 94,000 lb per sq. in. respectively.

It will be shown later that these strength values can be greatly exceeded with little difficulty. Furthermore, since a steel strut would naturally be of hollow section, the material would be distributed to better advantage than in a wooden strut of solid section. Therefore, a steel strut will have a radius of gyration greater than that of a wooden strut of the same length and same outer dimensions of section.

It is evident from the above that there would be a distinct advantage in making all compression members of steel.

To compare steel favorably, weight for weight, with ash and spruce, in tension, the steels would have to have tensile strengths of 195,000 and 187,000 lb per sq. in., respectively.

It will later be shown that these strength values can be appreciably exceeded by the employment of heat-treated special steels, but there would be a number of difficulties to overcome before they could be used to advantage. It would be necessary to have these steels in a thoroughly annealed condition during the process of working to shape, punching rivet holes, etc., and the finished members would have to be heat-treated.

These members would often be made from thin sheet steel and the process of heat-treating would be very difficult, as there would be considerable danger of the steel warping or being injured in handling. The size and shape of the members might also cause difficulty in heat-treating. There is, however, no reason why most of these obstacles cannot be overcome by careful design and refinement of methods of working.

Steel ought not to vary more than plus or minus ten per cent from its average strength value, but a variation of plus or minus forty per cent in the strength of wood is not at all unusual. It is therefore evident that if steel construction were employed, lower factors of safety could be adopted than are specified at present.

Most of the difficulty that has been encountered in steel construction has been due to the employment of unsatisfactory methods of connecting the structural members. Brazing and welding have been used almost exclusively for this purpose, since they were the easiest methods to employ, but a great deal of trouble has resulted from their adoption.

In brazing and welding the quality of the steel is greatly impaired to the necessity of heating, and in the case of heat-treated steels, the effect of the heat treating is destroyed. If brazing is carefully done, overheating may be avoided, but brazed connections often fail in service when highly stressed or when subjected to vibratory stresses.

In welding, the steel is necessarily severely overheated and its quality is greatly impaired. Welds may be refined by heat-treating, but often, due to the bulk of certain structural members that have been welded together, it is impossible to heat-treat them.

Refining is possible by the application of an oxy-acetylene torch, but this method is unsatisfactory since it requires a very skilled workman who can judge, by color the proper refining temperatures. Even though this method of refining is properly carried out, the effects of any previous heat-treatment will be destroyed and the material will be thoroughly annealed.

As the steels used in airplane construction are usually very thin, it is obvious that serious overheating in brazing or welding is certain to occur occasionally, and there will always be an element of doubt in regard to the efficiency of a brazed or welded connection.

It is evident from the above discussion that riveting is the only satisfactory and positive method of connecting structural members, and there is no reason why satisfactory riveted connections cannot be developed.

There seems to be a tendency among most designers and manufacturers of airplanes to use wood in preference to steel, if possible, and where it is necessary to use steel, extremely ductile steels of low tensile strength are usually employed. The arguments usually given against the use of steel and particularly against the use of heat-treated special steels are that there is danger of failure under the shocks to which the members are subjected and that vibration will cause the steel to "crystallize." These arguments are absurd and absolutely without foundation.

Ductility is possibly essential in steel members which are subject to shocks, since the elastic resilience of the material is often not great enough to absorb them, and the material will be stressed beyond its elastic limit, absorbing the shocks by taking on slight permanent deformation.

In motor cars, locomotives, etc., the structural members are sometimes subjected to severe shocks and it is essential that these members be ductile, but if we analyze the nature of the stresses that come upon the structure of an airplane we shall find that they are of an entirely different nature. In flight, an airplane is subjected to no shocks whatsoever, but in landing the landing gear and some of the body members are subjected to shocks, but these, however, are usually not severe.

Since ductility is always obtained at a sacrifice of strength, excessive ductility of steel members is unfavorable, and it is evident that all metal fittings and structural members, with the exception of a few body members and the landing gear, should be made of steels of great strength with a low ductility. In fact, but a small amount of ductility is necessary in the landing gear.

A well-known type of airplane, several hundred of which are now in service, is equipped with an axle of heat-treated 3½ per cent nickel steel tubing having a tensile strength in excess of 200,000 lbs. per square inch, an elongation of not more than twelve per cent and a reduction of area of not more than fifty per cent. Not one of these axles, in a period of over a year, has broken. This gives a good idea of the small amount of ductility required in those parts of an airplane which are subjected to the most severe shocks.

A very thorough investigation of the fatigue failure of materials was made by Prof. G. B. Upton of Cornell University, and a great deal of valuable information has been derived from his researches. He succeeded in proving conclusively that the fatigue failure of a material is the direct result of a gradual breaking down of the crystalline structure under the repeated loads to which it is subjected.

It was also determined that the crystalline structure of materials is fully as fine after it has failed in fatigue as it was before the test. In fact, the structure is finer, since numerous crystals have been sheared by the repeated application of load.

The theory that metals will crystallize under repeated or vibratory loading has been advanced to explain the failure of materials that were, due to improper treatment in the process of manufacture, coarsely crystalline to begin with. Furthermore, it is unreasonable to believe that vibration or repeated loads could possibly cause a large number of fine crystals to recrystallize into a small number of large crystals.

A very definite relation was found to exist between the number of applications of stress necessary to cause fatigue failure and the range of the stress. When plotted to logarithmic scale a straight line relation is found to exist between these two variables. It has been determined from a large number of tests that the number of applications of stress necessary to cause a fatigue failure of steel is roughly inversely proportional to the fifth power of the stress range.

The nature of the stresses to which an airplane is subjected are such that fatigue failure of the structural members is quite impossible. The following example will serve to prove this statement:

A particular piece of chrome-vanadium steel having an ultimate tensile strength of 190,000 lb. per sq. in. was found to withstand 250,000 applications of load when the stress range was 90,000 lb. per sq. in. It is therefore evident that the range of stress due to vibration is so small that it could not possibly cause a fatigue failure. A reasonably large stress range is possible in pulling out of dives, banking, encountering gusts, etc., but the frequency of these stresses is never great enough to cause fatigue failure.

Great care must be taken in the design and manufacture of metal fittings to avoid sharp corners, creeks and injury of the material. Large localized stresses are very often developed at sharp corners and frequently they result in failure of the material in service. In this particular type of fatigue failure, the localized stresses are so great that only a small number of applications of stress are necessary to cause failure.

The following data show some remarkable physical properties that were obtained by carefully heat-treating several typical special steels:

CHEMICAL COMPOSITION

| No. of Steel | C | Mn | P | S | Ni | Cr | |
|---|---|---|---|---|---|---|---|
| 1 | .30 | .70 | .025 | .017 | 3.41 | | |
| 2 | .33 | .46 | .018 | .018 | 3.21 | 1.05 | |
| 3 | .31 | .53 | .016 | .028 | .39 | 1.05 | .11 |

HEAT TREATMENT

| No. of Steel | Quench in Oil | Draw |
|---|---|---|
| 1 | 1475 deg. Fahr | 500 deg. Fahr |
| 2 | 1450 deg. Fahr | 600 deg. Fahr |
| 3 | 1550 deg. Fahr | 800 deg. Fahr |

PHYSICAL PROPERTIES

| No. of Steel | Ultimate Strength lb per sq. in. | Elongation | Reduction of Area |
|---|---|---|---|
| 1 | 260,000 | 13 per cent | 44 per cent |
| 2 | 285,000 | 12 per cent | 45 per cent |
| 3 | 220,000 | 15 per cent | 54 per cent |

In conclusion it may be said that the possibilities of steel in the construction of airplanes are very great, but the use of mild steels and the practice of welding and brazing must be largely discontinued if it is desired to make steel construction really successful.

# The Austro-Hungarian Seaplanes K.301 and A.25

*The Information Section of the Air Division furnishes the following description of two Austro-Hungarian seaplanes which have recently fallen into the hands of the Italian Air Service.*

### *The Three-Seater Seaplane K.301*

This machine was brought down by Italian aviators in the night of Jan. 12, 1917, and has proved a highly interesting specimen of Austrian seaplane construction, both because of its intrinsic qualities and because of the recent date at which it was captured.

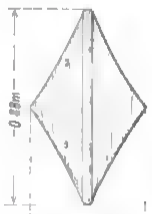
The seaplane K.301 is a single-pusher, biplane flying boat which resembles in its general lines the well known Lohner type, although it is somewhat larger than the standard seaplane of the latter firm.

Like the Lohner, the K.301 has the wings set at a pronounced retreat and the ailerons, upper only, are of trapezoidal shape. The span of the upper planes is 9.70 m., that of the lower planes, 7.20 m. The chord is 2.70 m. on the upper planes, and 2.20 m. on the lower planes. The ailerons are 3.47 m. long and 0.90 m. wide.

The planes are connected with one another on either side of the center section by three pairs of steel struts, each pair being braced in the longitudinal axis by steel tubes of 40 mm. outside diameter. The struts of each pair are spaced 120 m. (longitudinally), while the strut pairs are spaced 2.17 m. (transversely).

The tail group consists of an empennage 4.74 m. long and 1.27 m. wide, and of an elevator 4.74 m. long and 0.87 m. wide. Contrary to Lohner practice, the rudder is of the balanced type.

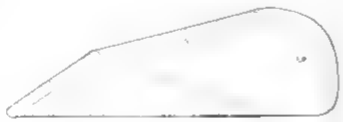

*Central News Photo Service* AUSTRIAN LOHNER FLYING BOAT CAPTURED BY THE ITALIANS *British Official Press Bureau*




REAR ELEVATION

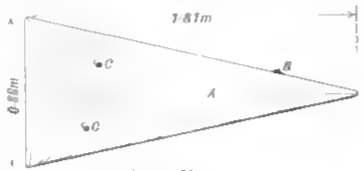
THREE-QUARTER FRONT VIEW

FRONT ELEVATION



THREE-QUARTER REAR VIEW

SIDE ELEVATION




PLAN VIEW

DETAILS OF A WING PONTOON OF THE K 301





The hull is of the general Lohner type and is fitted with two cockpits in tandem fashion. The forward cockpit is provided with a seat for the gunner and mounts a machine gun on a revolving turret which is armored, like on Austrian machines of an older type. In the after cockpit two seats are provided side by side for the pilot and the observer, a machine gun is mounted on a sliding carriage on the side of the observer. This arrangement is similar to that found on some Italian machines.

The hull is 12.50 m. long, 1.50 m. wide and 1.20 m. high, the step is 0.25 m. high.

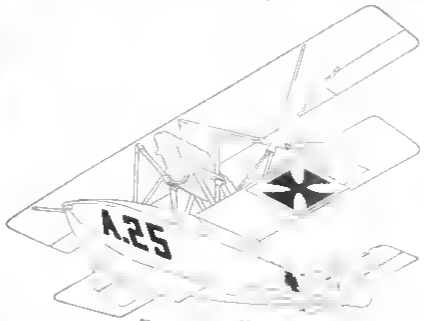
The power plant consists of a water cooled, 12-cylinder, V-type Warchalowski engine, which is rated 300 hp. and drives a pusher airscrew.

The wing pontoons, instead of being of the hemispherical shape so common on older Austrian seaplanes, have a very finely streamlined bow which thus ploughs through the surface of the water just like a ship.

The bomb carrying capacity of the K.301 is estimated at 400 kg. On examination, however, no bomb dropping device could be located for large bombs, although several hooks for smaller bombs were found. Two vertical pieces of wood, with a circular notch, were found fastened to the wing pontoons, and these may well be used for carrying large bombs, but it has not been possible to discover how they may be secured in them.

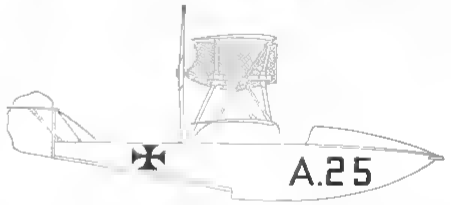
### *The Fighting Seaplane A.25*

This machine, which was captured on May 18, 1917, and consequently reveals recent Austrian practice, does not differ much from the usual fighting seaplane type. A few constructional features are, however, worthy of note, the most striking of these being the bracing system of the wing panels. The wing panels of the A.25 are braced by what appears in front and side elevation to be an N-truss, but which really consists of eight inclined struts all of which converge toward a central fitting. This system permits to dispense with transverse and longitudinal wire bracing, because all the struts form but one rigid structure which distributes all stresses uniformly over the surface of the wings. The struts are polished steel tubes with a fairing of laminated wood less than 1 mm. thick.



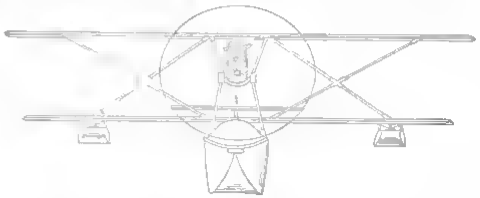

PERSPECTIVE VIEW

The two star trusses of the wing panels are furthermore connected with one another through the struts of the engine section, so that probably a greater rigidity is obtained throughout the whole lifting portion of the machine than has hitherto been achieved.




SIDE ELEVATION

The hull is carefully streamlined by a suitable laying of the side and bottom planking and shows a well worked out purpose of reducing head resistance to a minimum. This is also obvious from the streamlined casing of the engine and from the way the control cables are led, as far as possible, in the wake of the struts.



FRONT ELEVATION

The empennage is supported by two stays and two ties, and, in addition, by a vertical fin of laminated wood.

The dimensions of the machine are the following:

| | |
|---|---|
| Overall span | 8.00 m |
| Interplane gap | 1.65 m |
| Chord | 1.50 m. |
| Angle of incidence | about 0 |
| Length of hull | 6.50 m |
| Overall length | 7.35 m |
| Height above step | 0.85 m |
| Width at the step | 0.95 m. |
| Overall width of hull | 1.00 m. |
| Distance from bow to step | 3.45 m. |
| Distance from step to stern | 3.90 m. |
| Height of step | 0.16 m. |
| Offset of wing pontoons from centerline | 2.50 m. |

The power plant is a 6-cylinder Hiero Fingmotor, made to Warchalowski's patents by the Eisler & Co., A.-G., and develops 218 hp. at 1,400 r.p.m. The engine weighs 314 kg. and is fitted with Bosch starting magnetos. The propeller is a 200 hp. Hiero. Diameter, 2.72 m., pitch, 2.25-2.40 m.

# Government Specifications for Kiln-Drying Airplane Woods

**By Thomas D. Perry**

Inability to secure an adequate supply of three-year, air-dried spruce for airplane work has led the Aeronautical Engineering Division of the Signal Corps of the United States Army to develop process specification number 20,500, providing for the artificial drying of lumber. Some doubt still exists as to whether the lumber kiln-dried according to the specification is in every respect as strong, rigid and elastic as the air dried stock.

Exhaustive tests are now being conducted along this line, and the steps taken indicate the practical equality of the artificially dried with three-year air dried.

In the preparation of specification number 20,500, the services of the Forest Products Laboratory at Madison, Wis., were enlisted. This Laboratory under United States Government auspices has been conducting a series of tests on green, air-dried and kiln-dried lumber for a period of years, and with these tests as a basis the specifications were drawn. To make them readily understandable they have been reduced by the writer to chart form, in which the vertical distances represent temperatures, and relative humidities and the horizontal spaces indicate moisture content of the lumber and days of drying. An assumption has been made in plotting the horizontal dis-

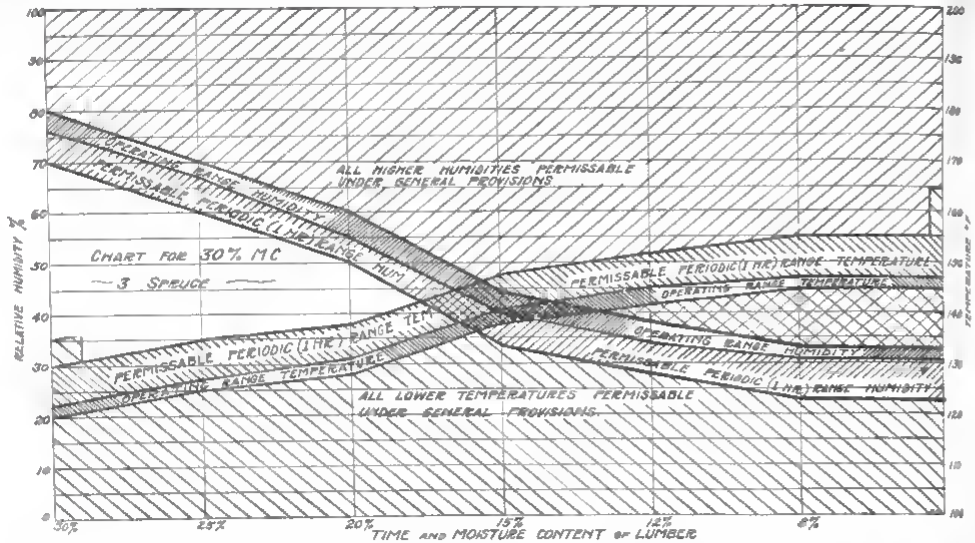



CHART I

tances that the intervals required to reduce moisture content are substantially equal, but this can cause no appreciable error.

Chart I shows the downward tendency of the humidity line and the upward slope of the temperature line, with the specified tolerances. The operating ranges shown by densest section, are exceedingly limited, and kiln operators will need to take many more frequent observations than usual, at least six read-

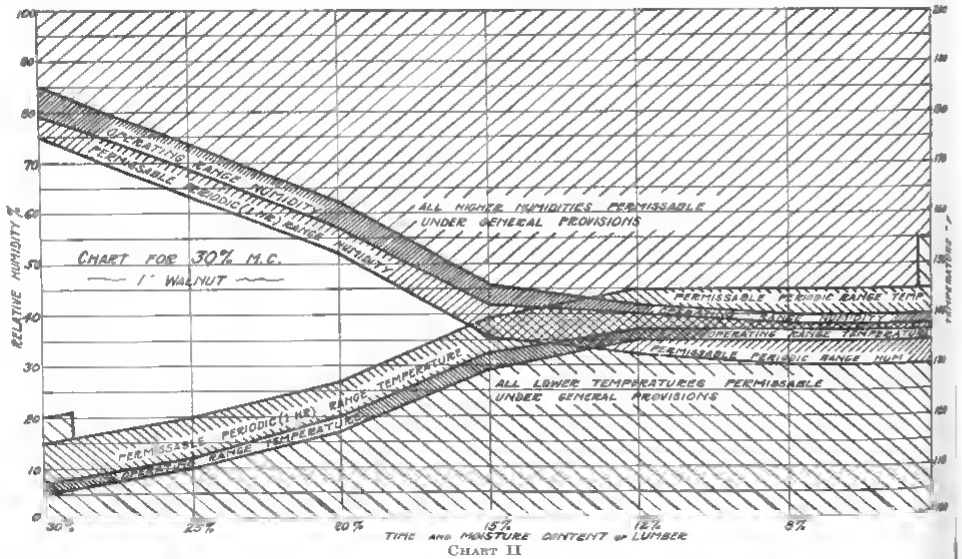



CHART II



ings every twenty-four hours. The maximum temperatures are much lower than customarily used on spruce, and the time must be correspondingly lengthened to allow 30 days for usual kilns on lumber shown in Chart I.

The initial and final steaming for moisture equalization on the surface and in the center of the board will produce high humidities, but these in the permissable range, and are, therefore, not plotted. Some question exists in the writer's mind as to the effect of the sudden initial and final increase of temperature; probably a gradual rise would be safer.

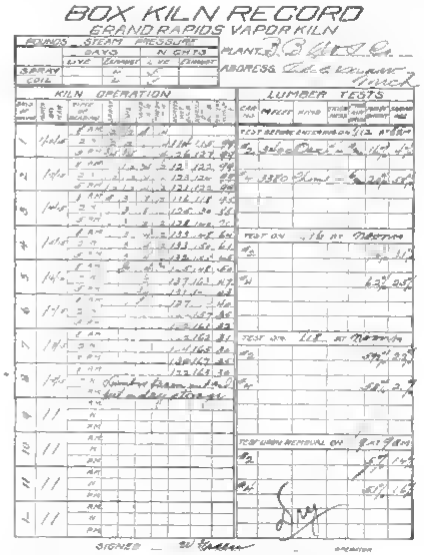
Users of vapor kilns will find that their normal humidity lines will be much higher than specified, but still within the permissable range. Safety would undoubtedly be maintained by correspondingly higher temperatures, but they cannot be used until a change is made to the present specifications as to these.

Chart II is for poplar, birch stock or hardwood, and temperatures are even lower than for spruce. The lumber, however, is usually one inch thick and can be dried in usual kilns in about 30 days.

Many kiln owners will wonder whether their present kilns can be operated within the limits of the specifications. In most instances the answer will be in the negative, for few installations possess the adequate and accurate control for temperature, humidity and circulation. The latter must provide hourly air changes, no less. Kilns of strength have been operated needlessly and no initiative has been offered nor encouragement given to kiln designers and manufacturers to supply kilns barred by the specifications until the segregation of kinds and thicknesses of lumber is provided.

In order to facilitate the analysis of kiln records it is suggested that operators keep a tabular record, making records as the drying process progresses. A typical record is shown in chart III. This can be varied to suit individual conditions.

A comparison with the government specifications can be readily made by plotting chart III on II, with the result shown in chart IV. The writer has intentionally taken a typical vapor kiln record on one inch oak at usual drying temperatures, which does not range within the specifications, in order to emphasize the discrepancies and to show the relation between usual drying conditions and the government requirements.


BOX KILN RECORD

GRAND RAPIDS VAPOR KILN

KILN OPERATION — LUMBER TESTS

KEY

CHART III

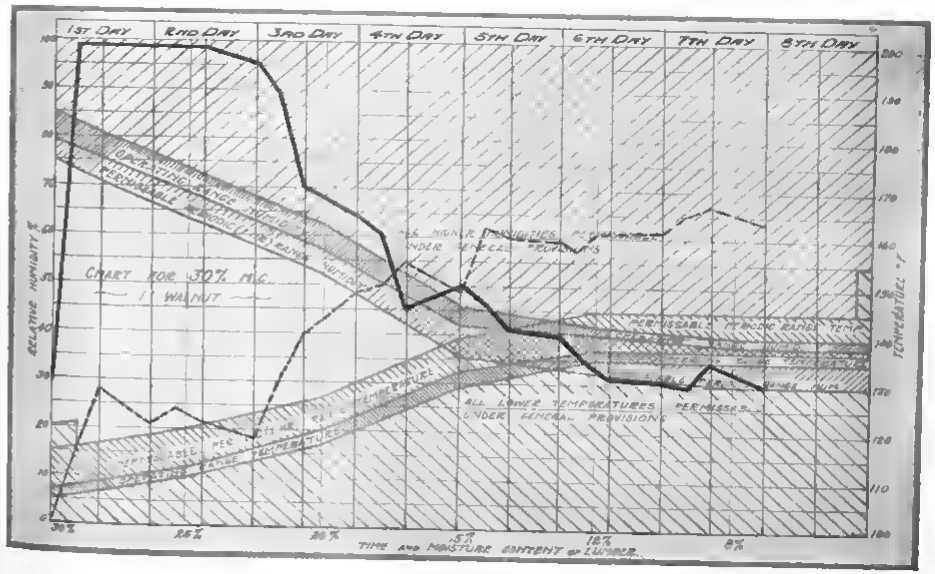



CHART IV

It is to be noted that one-inch oak and walnut take the same drying schedule

The comparative use of tabular records such as chart III and of graphic records similar to IV is recommended For clearness of record, the complete graphic chart for specification number 20,500 (chart II) should be printed in a faint ink, so that the actual operating lines stand out with clearness.

There is no doubt that Government inspectors will welcome the systematic use of complete records similar to the above.



# Radiators for Airplane Engines

The Auto Radiator Manufacturing Corp., manufacturer of the "Flexo" copper core radiators has investigated the problem of airplane engine radiators in a thorough manner and some interesting results are available

Data was obtained from field tests Owing to the part of the country in which the tests were run, large radiators were required on account of climatic conditions. Tests were made on several radiators of each type and an average taken Four types were considered:

(1) *Front Type* The front type is mounted directly back of the propeller and is usually attached to the machine by means of studs from the bottom This is a rigid mounting and if proper supports are not provided from the upper parts, the radiator will whip back and forth and cause leaks where the studs enter the lower water box, or tear the core loose where it is soldered to the tank. This type is also mounted by means of bolts through the lower part of the hood ledge This is the better of the two ways as the strain is distributed along the sides.

When this type is used with a vertical engine it may require large upper water tanks, in which case the frontal resistance per b h.p. run rather high

This type also usually carries considerable water, due to the tank around the hole through which the propeller shaft passes

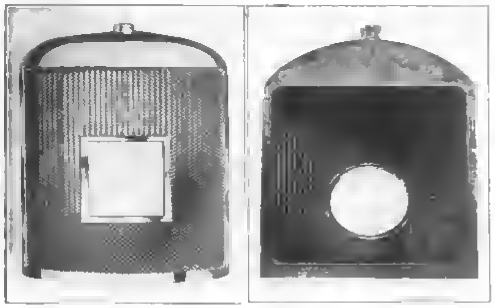


FIG. 1. FRONT TYPE
(Mounted back of Propeller)
FROM FIELD TESTS

| | |
|---|---|
| Cooling per b h.p. | 117 sq in. |
| Core per b h.p. | 0.39 lb. |
| Water per b h.p. | 0.42 lb. |
| Frontal per b h.p. | 4 sq in. |
| Radiator per b h.p. | 0.81 lb. |
| Radiator and Water per b h.p. | 0.81 lb. |

The large water box and tank around the hole, of course, add to the weight of the radiator, bringing the total weight very high

The front type is also somewhat complicated in manufacture owing to the curved lines which conform to the shape of the body and the lines round the propeller hole This involves extra material and labor

(2) *Side Type* There are many kinds of side type radiators, but ordinarily they are mounted alike on the sids of the body with studs from below and attached to the struts from above by the same means. The manner of mounting is good in that there is little chance to whip

The side type is always somewhat heavy for two reasons Extra parts for two radiators are needed, and as the radiator is lower than the water jackets, it requires more tankage and core. The manufacturing cost of this type runs quite high but not so high as the front type, because of plain cores and less skilled labor

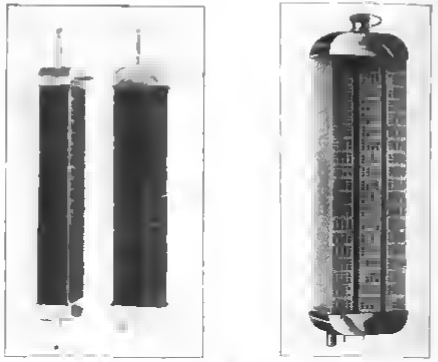


FIG. 2 SIDE TYPE
(Mounted on Side of Body)
FROM FIELD TESTS

| | |
|---|---|
| Cooling per [illegible] | 104 sq in. |
| Core per b h.p. | 0.46 lb. |
| Water per b h.p. | 0.25 lb. |
| Frontal per b h.p. | 7.2 sq in. |
| Radiator per b h.p. | 0.66 lb. |
| Radiator and Water per b h.p. | 0.81 lb. |

(3) *Overhead Type.* The overhead type is usually mounted above the aviator's head and attached by means of brackets to the struts. The location is very favorable because of its height above the engine However, should the radiator become punctured, the aviator is liable to become scalded

The frontal resistance is perhaps not so large because the radiator does not have to be large on account of its favorable location The radiator hinders the lifting power of the upper plane to a certain extent

The overhead type must be hung from the sides and owing to the fact that strong reinforcements are required, this type

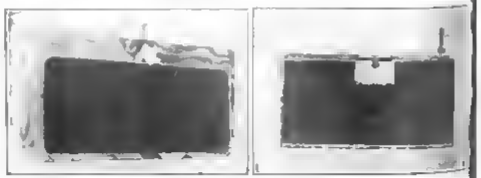


FIG. 3 OVERHEAD TYPE
(Mounted above Driver)
FROM FIELD TESTS

| | |
|---|---|
| Cooling per h.h.p. | 112 sq in. |
| Core per h.h.p. | 0.25 lb. |
| Water per h.h.p. | 0.31 lb. |
| Frontal per h.h.p. | 2.7 sq in. |
| Radiator per h.h.p. | 0.38 lb. |
| Radiator and Water per h.h.p. | 0.68 lb. |



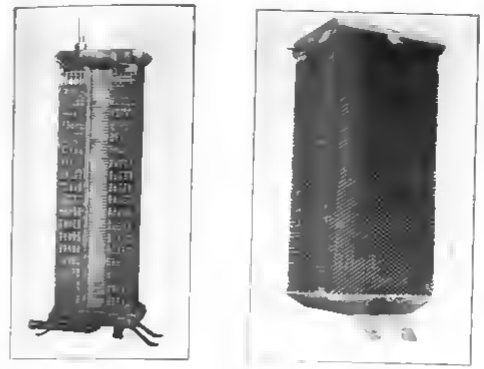


FIG 4 OVER ENGINE TYPE
(Mounted over Engine)
FROM FIELD TESTS

| | |
|---|---|
| Cooling per h.h.p. | 121 sq in. |
| Core per h.h.p. | 0.31 lb. |
| Water per h.h.p. | 0.25 lb. |
| Frontal per h.h.p. | 5 sq in. |
| Radiator per h.h.p. | 0.66 lb. |
| Radiator and Water per h.h.p. | 0.63 lb. |

is excessively heavy for the work it performs. Because of its location this type must be made wide, and a large upper tank is required which increases the weight per h.h.p.

It is possible to manufacture this type without rounding the corners of the core, but more skilled labor is required because of the necessary finishing in the assembling.

(4) *Over Engine Type* This type is mounted on the top of the engine on spring legs which are bolted to the engine by means of the cylinder head cap screws and also is supported from the top on either side from the struts, making a very good mounting. The location is favorable with the only disadvantage that it shuts off some of the aviator's view The actual frontal resistance of this type is less by one half of that shown on the table, one core being back of the other.

The over engine type does not require large water tankage due to the long cores and has many good manufacturing points such as plain square cores, perforated strip sides, and individual water boxes soldered to the cores, and takes less skilled labor than any other type.

RESULTS OF TESTS

| | Sq. In Cooling per HP | Wt. of Core per HP | Wt. of Water per HP | Frontal Sq. In per HP | Wt. of Radiator per HP | Wt. of Radiator and Water per HP |
|---|---|---|---|---|---|---|
| Front Type | 117 | 39 | 42 | 4 | .81 | 0 |
| Side Type | 104 | 46 | 25 | 7.2 | .55 | .81 |
| Overhead Type | 112 | 25 | .31 | 2.7 | .38 | .68 |
| Over Engine Type | 121 | 31 | .25 | 5 | .56 | .63 |

The "Flexo" radiator cores have a combination thin and wide water travel and are soldered at all points of contact. These cores are flexible and will stand severe landing shocks without injury They can be frozen any number of times without being damaged.

# Slip Stream in Relation to Stability at Stalling Speeds

By A. A. Merrill

In testing a model for static longitudinal stability it is common practice to set the model up on the axis of the balance in the wind tunnel with its span vertical and the chord of its surface at the desired angle of incidence. The force down the wind, i.e., drag or $K_x$, and the force across the wind, i.e., lift or $K_y$ are then measured From these the resultant force may be computed as it equals the square root of the sum of the squares of these two forces.

Also, as the axis of the balance does not pass through the center of pressure of the model, there will be a couple about this axis which is measured by the torsion of a wire. If we

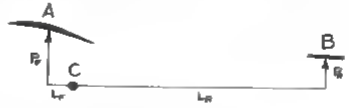



FIG 1

divide the magnitude of this couple by the magnitude of the resultant force, we will get the vertical distance of this resultant force from the axis We are then able to plot on a side elevation of the model the position of this resultant force since we know its line of action, point of application, direction and magnitude

We do this for all flying angles and we get a series of lines called force vectors and from this series we can determine the static stability of the model. Thus, a model is statically stable if the vectors follow the progression of the angles of incidence, i.e., if the vector for 2 deg. is behind that for 1 deg., the vector for 3 deg. behind that for 2 deg and so on.

In practice these vectors generally converge upward which means that the center of gravity must lie below the point of convergence if the machine is to be stable This, of course, is common knowledge to all familiar with laboratory work in aeronautics

It is generally supposed that the position of the vectors is constant for a given model regardless of air speed, but this is not true unless the machine is gliding without power With power the velocity of the slip stream alters the position of the vectors And this fact may show how a machine may tend to stall with loss of power

In Fig. 1, let $A$ be the main surface, $B$ the tail and $C$ the center of gravity If the machine is flying at a large angle, the resultant pressure on the main surface lies forward of the

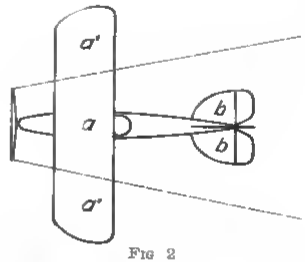



FIG 2

center of gravity and tends to stall the machine, while the force on the tail tends to maintain equilibrium. The forces are shown to be vertical merely for the sake of illustration. The equation of equilibrium is $PFLF = PRLR$

In Fig 2 is shown the approximate sphere of action of the propeller slip stream When power is shut off, it is only the center part of the wing that is affected, but the lift on the whole of the tail surfaces is diminished, even though the tail is so far from the propeller that slip stream affects it less than the wings. It is possible, therefore, that the lift on the main surfaces may be diminished by a smaller fraction than lift on tail surfaces, and the equilibrium is broken, so that there is a tendency to stall

# International Aircraft Standards

*(Continued from last issue)*

### *3S28—Specifications for Alloy Steel Sheet*

GENERAL.—1. The general specifications 1G1 shall form, according to their applicability, a part of these specifications.

MATERIAL.—2. The material for these sheets shall be chosen from the I. A. S. B. standard alloy steels listed below. The composition shall be stated by the manufacturer or contractor and is further limited as follows: Carbon, not over 0.25 per cent.

MANUFACTURE.—3. (*a*) The steel shall be manufactured or at least finished, by the open hearth electric-furnace, or crucible process.

(*b*) A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

(*c*) Sheets, unless ordered cold-rolled shall be full pickled.

(*d*) Sheets are to be well and uniformly annealed in accordance with good commercial practice. For sheets lighter than 0.065 in. (1.65 mm.), box annealing is preferred. For sheets 0.065 in. (1.65 mm.) and thicker, open annealing is preferred.

*Heat Treatment.*—(*e*) The manufacturer shall state the heat treatment recommended to give the physical properties specified.

WORKMANSHIP AND FINISH.—4. (*a*) The sheets must be commercially flat, clean, smooth, free from seams, laminations, blisters and other surface defects. They must be uniform in quality, and within the stipulated margins of manufacture.

(*b*) Any sheet may be rejected because of injurious defects or faults in manufacture at any time, notwithstanding that it has previously been accepted by the inspector; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

PHYSICAL PROPERTIES AND TESTS.—5. (*a*) Specimens cut in any direction from the heat treated sheets shall have the following properties:

*Tensile Test.*—(*b*) Minimum tensile strength 100 000 lb. per sq. in. (70.30 kg./mm.²), minimum yield point 75 000 lb. per sq. in. (52.73 kg./mm.²), minimum elongation 15 per cent. in 4 in. (101.6 mm.).

*Bend Test.*—(*c*) Strips cut from annealed sheets shall stand being bent cold through an angle of 180 deg., in an axis parallel to a radius equal to the thickness of the sheet without fracture.

(*d*) Strips 1½ in. (31.75 mm.) wide cut from annealed sheets and with edges rounded, shall stand reversed bending cold through an angle of 90 deg. for not less than three complete reversals without fracture. The test is to be made in a square-nose vise, the edges over which the specimen is bent being rounded to a radius equal to three times the thickness of the sheet.

SELECTION OF TEST SPECIMENS.—6. Three sheets shall be taken from each annealing box to represent the top, middle and bottom of the stack or 1 sheet from each 25 when sheets are open annealed. One tensile, one bending, and one reverse bending test shall be made from each sheet selected.

DIMENSIONS AND TOLERANCES.—7. The dimensions and tolerances shall be those given in the table below and in the specifications 3S11. The thickness will be specified in decimals of an inch or millimeters.

DELIVERY, PACKING, AND SHIPPING.—8. (*a*) Sheets shall be cut to the required dimensions and shall be ordered in as narrow widths as can be used.

(*b*) All sheets shall be oiled for protection against corrosion.

(*c*) Sheets 0.065 in. (1.65 mm.) or thinner shall be boxed, the weight of the box with contents not to exceed 220 lb. (100 kg.).

(*d*) Sheets thicker than 0.065 in. (1.65 mm.) up to and including 0.125 in. (3.18 mm.) shall be crated, the weight of crate and contents not to exceed 220 lb. (100 kg.).

(*e*) Sheets thicker than 0.125 in. (3.18 mm.) may be bundled, the weight of bundle not to exceed 220 lb. (100 kg.).

CHEMICAL COMPOSITION OF STANDARD ALLOY STEELS

NICKEL STEELS

| Number | Carbon | Manganese | Phosphorus maximum | Sulphur maximum | Nickel | Chromium |
|---|---|---|---|---|---|---|
| 2315 | 0.10–0.20 | 0.30–0.60 | 0.040 | 0.045 | 3.25–3.75 | |
| 2320 | 0.15–0.25 | 0.30–0.60 | 0.040 | 0.045 | 3.25–3.75 | |
| 3115 | 0.10–0.20 | 0.30–0.60 | 0.040 | 0.045 | 1.00–1.50 | 0.45–0.75 |
| X3125 | 0.20–0.30 | 0.30–0.60 | 0.040 | 0.045 | 1.00–1.50 | 0.45–0.75 |
| 3120 | 0.15–0.25 | 0.30–0.60 | 0.040 | 0.045 | 1.00–1.50 | 0.45–0.75 |
| 3215 | 0.10–0.20 | 0.30–0.60 | 0.040 | 0.045 | 3.25–3.75 | 1.20–1.60 |
| 3220 | 0.15–0.25 | 0.30–0.60 | 0.040 | 0.045 | 3.25–3.75 | 1.20–1.60 |
| 3315 | 0.10–0.20 | 0.30–0.60 | 0.040 | 0.045 | 3.25–3.75 | 1.40–1.75 |
| 3320 | 0.15–0.25 | 0.30–0.60 | 0.040 | 0.045 | 3.25–3.75 | 1.40–1.75 |

NICKEL-CHROMIUM STEELS

| Number | Carbon | Manganese | Phosphorus maximum | Sulphur maximum | Nickel | Chromium |
|---|---|---|---|---|---|---|
| 3120 | 0.15–0.25 | 0.30–0.60 | 0.040 | 0.045 | 1.00–1.50 | 0.45–0.75 |
| 3215 | 0.10–0.20 | 0.30–0.60 | 0.040 | 0.045 | 3.25–3.75 | 1.20–1.60 |
| X3115 | 0.10–0.20 | 0.30–0.60 | 0.040 | 0.045 | 3.25–3.75 | 1.40–1.75 |
| 3315 | 0.10–0.20 | 0.30–0.60 | 0.040 | 0.045 | 3.25–3.75 | 1.40–1.75 |

CHROMIUM-VANADIUM STEELS

| Number | Carbon | Manganese | Phosphorus maximum | Sulphur maximum | Chromium | Vanadium minimum |
|---|---|---|---|---|---|---|
| 6120 | 0.15–0.25 | 0.30–0.60 | 0.040 | 0.045 | 0.80–1.10 | 0.15 |

When electric or crucible furnace steel is specified in the order the maximum allowable percentages of phosphorus and sulphur may, at the option of the purchaser be limited to 0.03 per cent.

TABLE OF TOLERANCES FOR STANDARD SHEET STEELS

| Thickness | | Tolerances for sheets 14 inches (35.6 cm.) wide and under | | Tolerances for sheets over 14 inches (35.6 cm.) wide | |
|---|---|---|---|---|---|
| *Inches* | *Millimeters* | *Inches* | *Millimeters* | *Inches* | *Millimeters* |
| 0.0 0.020 | 0.51 | +0.001 | −0.003 | ±0.002 | ±0.05 |
| 0.021 .030 | 0.53–.76 | +.002 | −.003 | ± .003 | ± .08 |
| .031 .040 | .79–1.02 | ± .003 | ± .08 | ± .004 | ± .10 |
| .041 .050 | 1.05–1.27 | ± .004 | ± .10 | ± .005 | ± .13 |
| .051 .065 | 1.30–1.64 | ± .004 | ± .10 | ± .006 | ± .15 |
| .066–.080 | 1.68–2.03 | ± .004 | ± .10 | ± .006 | ± .15 |
| .081 .100 | 2.06–2.54 | ± .005 | ± .13 | ± .007 | ± .18 |
| .101 .120 | 2.57–3.05 | ± .006 | ± .15 | ± .008 | ± .20 |
| .121 .250 | 3.08–6.35 | ± .006 | ± .15 | ± .008 | ± .20 |

### *3S18—Specifications for Alloy Steel Bars and Billets for Case Hardening*

1130 000 Lbs. Per Sq. In. Tensile Strength.

GENERAL.—1. The general specifications, 1G1, shall form according to their applicability, a part of these specifications.

MATERIAL.—2. The material for these bars shall be chosen from among the I. A. S. B. standard alloy steels listed below. The composition chosen shall be stated by the manufacturer or contractor. It is further limited as follows: Carbon not over 0.25 per cent.

MANUFACTURE.—3. (*a*) The steel shall be manufactured or at least finished by the open hearth, electric furnace, or crucible process.

(*b*) A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

(*c*) The billets from which the bars are made are to be rough turned or chipped to remove all surface defects which might produce seams in the finished bar. No undercutting in chipping will be allowed.

(*d*) The steel manufacturer shall state the heat treatment recommended for case hardening this steel and to give the physical properties specified.

WORKMANSHIP AND FINISH.—4. (*a*) The bars are to be sound, commercially straight, free from pipes, laps, cracks, twists, seams, and chamfered ends, and are to have a workmanlike finish. They are to be uniform in quality within the stipulated margins of manufacture, capable of that it has previously been accepted by the inspector; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to materials fabricated after export.

PHYSICAL PROPERTIES AND TESTS.—5. The bars shall have the following physical properties:

*Tensile Test.*—(*a*) Minimum tensile strength, 130 000 lb. per square inch (91.39 kg./mm.²), minimum yield point, 120 000 lb. per square inch (84.36 kg./mm.²), minimum elongation in 2 in. (50.8 mm.) or proportional gage length to per cent.

*Hardness Test.*—(*b*) After carbonizing and tempering the case must show a minimum Shore scleroscope hardness number of 75.



*Impact Test.*—(*c*) When impact testing machines of the pendulum type are available, tests shall be carried out if required to determine the specific impact work of rupture of the core in foot pounds (or kilogram meters). Results materially lower than the average for this type of material will be sufficient cause for further investigation (or reheat-treatment) of the material.

SELECTION OF TEST SPECIMENS.—6. Three bars of each size rolled from a heat shall be taken and test pieces prepared in accordance with the I. A. S. B. standards. Each test piece and the bar from which it is cut shall be stamped with an identifying number. Should any of the test pieces, after being heat treated in the manner recommended by the steel manufacturer, fail to show the prescribed physical properties, new test pieces and bars shall be made from the same lot. At the option of the purchaser the steel manufacturer may recommend a different heat treatment for the second set of test specimens and bars, and he may make such tests as he desires from the remainder of the three bars taken for the tests. Should any of the three specimens taken for the first tests fail to show the required physical properties, the bars of that heat of the size represented by the specimens shall be rejected.

DIMENSIONS AND TOLERANCES.—7. The dimensions and tolerances shall be those of the specifications 3S11.

DELIVERY, PACKING AND SHIPPING.—8. (*a*) The bars shall be delivered in the annealed state.

(*b*) The bars shall in general be grouped in bundles weighing not more than 250 lb. (113.4 kg.) unless otherwise agreed between manufacturer and purchaser. The heat number and the I. A. S. B. steel serial numbers shall be plainly marked on a metal tag attached to each bundle. If bars are not so grouped and handled each bar shall be plainly marked with the heat number and the I. A. S. B. steel serial number.

TABLE 1

STANDARD STEEL BARS. ROUND OR SQUARE.

| Size of bar (diameter or width across flats) | | Hot rolled — Tolerance | | Bright rolled and drawn — Size of bar (diameter or width across flats) | | Tolerance | |
|---|---|---|---|---|---|---|---|
| *Inches* | *Millimeters* | *Inch* | *Millimeters* | *Inches* | *Millimeters* | *Inch* | *Millimeter* |
| 0–0.31 | 0–7.87 | +0.010 | +0.25 | 0–0.500 | 0–12.70 | −0.002 | −0.05 |
| 0.32–0.46 | 8.13–11.68 | +.015 | +.38 | 0.501–0.750 | 12.73–19.05 | −.003 | −.08 |
| 0.47–0.60 | 11.94–15.24 | +.020 | +.51 | 0.751–1.000 | 19.08–25.40 | −.004 | −.10 |
| 0.61–0.80 | 15.49–20.32 | +.025 | +.64 | 1.001–1.500 | 25.43–38.10 | −.005 | −.13 |
| 0.81–1.00 | 20.57–25.40 | +.030 | +.76 | 1.501–2.000 | 38.13–50.80 | −.006 | −.15 |
| 1.01–1.25 | 25.65–31.75 | +.040 | +1.02 | 2.001–2.500 | 50.83–63.50 | −.007 | −.18 |
| 1.26–1.50 | 32.00–38.10 | +.050 | +1.27 | 2.501–3.000 | 63.53–76.20 | −.008 | −.20 |
| 1.51–1.75 | 38.35–44.45 | +.060 | +1.52 | 3.001–3.500 | 76.23–88.90 | −.009 | −.23 |
| 1.76–2.00 | 44.70–50.80 | +.070 | +1.78 | 3.501–4.000 | 88.93–101.60 | −.010 | −.25 |
| 2.01–2.50 | 51.05–63.50 | +.080 | +2.03 | 4.001–4.500 | 101.63–114.30 | −.011 | −.28 |
| 2.51–3.00 | 63.75–76.20 | +.090 | +2.29 | 4.501–5.000 | 114.33–127.00 | −.012 | −.30 |
| 3.01–3.50 | 76.45–88.90 | +.100 | +2.54 | 5.001–6.000 | 127.03–152.40 | −.015 | −.38 |
| 3.51–4.00 | 89.15–101.60 | +.110 | +2.79 | | | | |
| 4.01–4.50 | 101.85–114.30 | +.120 | +3.05 | | | | |
| 4.51–5.00 | 114.55–127.00 | +.130 | +3.30 | | | | |
| 5.01–6.00 | 127.25–152.40 | +.150 | +3.81 | | | | |

TABLE 2.

STANDARD STEEL BARS, HEXAGON.

| Size of bar (width across flats) | | Hot rolled — Tolerance | | Bright rolled and drawn — Size of bar (width across flats) | | Tolerance | |
|---|---|---|---|---|---|---|---|
| *Inches* | *Millimeters* | *Inch* | *Millimeters* | *Inches* | *Millimeters* | *Inch* | *Millimeter* |
| 0–0.375 | 0–9.52 | −0.010 | +0.25 | 0–0.344 | 0–8.74 | −0.002 | −0.05 |
| 0.376–0.500 | 9.55–12.70 | −.015 | +.38 | 0.344–0.938 | 8.74–23.83 | −.003 | −.08 |
| 0.501–1.000 | 12.73–25.40 | −.020 | +.51 | 0.939–2.000 | 23.85–50.80 | −.004 | −.10 |
| 1.001–1.500 | 25.43–38.10 | −.025 | +.64 | 2.001–3.000 | 50.83–76.20 | −.005 | −.13 |
| 1.501–2.000 | 38.13–50.80 | −.030 | +.76 | 3.001–4.000 | 76.23–101.60 | −.006 | −.15 |
| 2.001–2.500 | 50.83–63.50 | −.035 | +.89 | | | | |
| 2.501–3.000 | 63.53–76.20 | −.040 | +1.02 | | | | |

TABLE 3

STANDARD STEEL SHEETS

| Thickness | | Tolerance for sheets 14 inches (35.6 cm.) wide and under | | Tolerance for sheets over 14 inches (35.6 cm.) wide | |
|---|---|---|---|---|---|
| *Inch* | *Millimeter* | *Inch* | *Millimeter* | *Inch* | *Millimeter* |
| 0–0.01 | 0–0.25 | +0.001<br>−0.003 | +0.03<br>−0.08 | ±0.002 | ±0.05 |
| 0.011–0.020 | 0.28–0.51 | +.002<br>−.003 | +.05<br>−.08 | ± .003 | ± .08 |
| 0.021–0.030 | 0.53–0.76 | +.002<br>−.004 | +.05<br>−.10 | ± .003 | ± .08 |
| 0.031–0.040 | 0.79–1.02 | ± .003 | ± .08 | ± .004 | ± .10 |
| 0.041–0.050 | 1.04–1.27 | ± .003 | ± .08 | ± .004 | ± .10 |
| 0.051–0.065 | 1.30–1.65 | ± .004 | ± .10 | ± .004 | ± .10 |
| 0.066–0.080 | 1.68–2.03 | ± .004 | ± .10 | ± .005 | ± .13 |
| 0.081–0.100 | 2.06–2.54 | ± .005 | ± .13 | ± .006 | ± .15 |
| 0.101–0.120 | 2.57–3.05 | ± .006 | ± .15 | ± .007 | ± .18 |
| 0.121–0.250 | 3.07–6.35 | ± .006 | ± .15 | ± .008 | ± .20 |

SHEET TESTS.—1. The following tolerances shall be allowed on the outside diameter of tubes:

Seamless tubes:

For tubes under 1.5 in. (38.1 mm.) diameter = 0.0065 in. (0.165 mm.).

For tubes over 1.5 in. (38.1 mm.) diameter = 0.007 in. (0.178 mm.).

Welded tubes:

For tubes under 1.5 in. (38.1 mm.) diameter = 0.006 in. (0.15 mm.).

For tubes over 1.5 in. (38.1 mm.) diameter = 0.0075 in. (0.191 mm.).

The tolerances on coulissant or telescoping tubes shall be decided between manufacturer and purchaser.

The permissible limit of variation of wall thickness shall be 10 per cent. of the dimensions specified.

WIRES AND CABLES.—2. The following tolerances will be allowed on wires and cables:

*High-Strength Steel Wire.*—(*a*) A permissible variation of 0.002 in. (0.051 mm.) above gauge on all sizes will be accepted, but no wire will be accepted having a variation of more than 0.0005 in. (0.013 mm.) below gauge.

*19 Nonflexible Steel Wire Cable.*—(*b*) There shall be no permissible variation in diameter below size. Cable having a diameter of 0.031 (1/32) to 0.156 in. (5/32) in. (0.79 to 3.97 mm.), inclusive, shall have a permissible variation of 10 per cent. above size and cable having a diameter of 0.1875 (3/16) to 0.375 (3/8) in. (4.76 to 9.53 mm.) inclusive shall have a permissible variation of 7 per cent. above size.

*7 × 7 Flexible Steel Wire Cable.*—(*c*) There shall be no permissible variation in diameter below size. Cable having a diameter of 0.063 (1/16) to 0.094 in. (3/32) in. (1.59 to 2.38 mm.) inclusive, shall have a permissible variation of 12 per cent. above size, cable having a diameter of 0.125 (1/8) to 0.187 (3/16) in. (3.18 to 4.76 mm.), inclusive shall have a permissible variation of 10 per cent. above size and cable having a diameter of 0.2187 (7/32) to 0.375 (3/8) in. (5.56 to 9.53 mm.) inclusive shall have a permissible variation of 7 per cent. above size.

*7 × 19 Extra Flexible Steel Wire Cable.*—(*d*) There shall be no permissible variation in diameter below size. Cable having a diameter of 0.125 (1/8) to 0.187 (3/16) in. (3.18 to 4.76 mm.), inclusive shall have a permissible variation of 10 per cent. above size, and cable having a diameter of 0.218 (7/32) to 0.375 (3/8) in. (5.56 to 9.53 mm.) inclusive shall have a permissible variation of 7 per cent. above size.

### *4P2—Specifications for Aircraft Ferrules and Thimbles*

GENERAL.—1. The general specifications, 1G1, shall form according to their applicability, a part of these specifications.

MATERIAL.—2. Thimbles shall be manufactured of I. A. S. B. standard No. 1010 steel sheet, cold rolled and annealed.

Ferrules shall be manufactured of the same steel as is used for the wire, namely, 1 A S B standard steels No 1005, No. 1070, or No 1080

MANUFACTURE—3. (a) Steel wire for winding into ferrules shall be uniformly coated with pure tin to solder readily.

(b) All thimbles shall be smoothly and evenly electro-galvanized

DIMENSIONS AND TOLERANCES.—4 (a) Ferrules and thimbles shall conform within limits specified to the dimensions given in the tables and drawings

(b) The manufacturer shall provide hardened pin gages for all sizes of thimbles and ferrules and such gages after being approved by the Government shall be used by the inspectors for determining all internal dimensions and shapes.

DELIVERY PACKING AND SHIPPING.—5 (a) Ferrules and thimbles shall be packed and shipped in fiber or pasteboard boxes containing 1 000 each.

(b) A label on each box shall be marked with order number or other distinguishing marks, size, material, evidence of inspection, etc., as required

INSPECTION AND REJECTION.—6. The inspector shall examine one sample taken at random from a box of 1 000 ferrules or thimbles and determine whether it conforms to these specifications

### I A. S. B STANDARD TINNED STEEL AIRCRAFT FERRULES.

ENGLISH UNITS.

| American Wire Gage (B & S.) | A and B | D | E | Approximate weight 1,000 pieces. |
|---|---|---|---|---|
| | *Inch.* | *Inch* | *Inch* | *Pounds* |
| 8 | 0 128 | 0 130 | 0 260 | 34 50 |
| 9 | 114 | 118 | 232 | 23 00 |
| 10 | 102 | 104 | 208 | 17 00 |
| 11 | 091 | 093 | 186 | 11 75 |
| 12 | 081 | 083 | 166 | 8 50 |
| 13 | 072 | 074 | 148 | 6 03 |
| 14 | 064 | 066 | 132 | 4 50 |
| 15 | 057 | 059 | 118 | 3 10 |
| 16 | 051 | 053 | 106 | 2 09 |

METRIC UNITS.

| American Wire Gage (B & S. | A and B | D | E | Approximate weight, 1,000 pieces |
|---|---|---|---|---|
| | mm | mm | mm | *kg* |
| 8 | 3 25 | 3 30 | 6 60 | 15 56 |
| 9 | 2 91 | 2 96 | 5 92 | 10 43 |
| 10 | 2 58 | 2 64 | 5 26 | 7 71 |
| 11 | 2 31 | 2 36 | 4 72 | 5 33 |
| 12 | 2 06 | 2 10 | 4 20 | 3 86 |
| 13 | 1 83 | 1 88 | 3 76 | 2 74 |
| 14 | 1 63 | 1 68 | 3 36 | 2 04 |
| 15 | 1 44 | 1 50 | 3 00 | 1 41 |
| 16 | 1 29 | 1 34 | 2 68 | 55 |

Dimensions A and B (see Fig. 1) are minimum allowance + 0.002 in (0 05 mm.)

The section of gage bar having semi circular edges, as shown in Fig 2, shall pass through ferrules with a clearance of approximately 0.003 in (0 08 mm ).

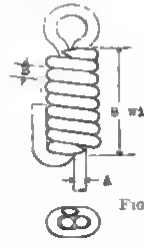



FIG. 1


FIG 2

### I A. S. B STANDARD GALVANIZED STEEL AIRCRAFT THIMBLES

ENGLISH UNITS

| Size | A | E | C | D | E. | Approximate weight, 1 000 pieces. |
|---|---|---|---|---|---|---|
| | *Inch.* | *Inch* | *Inch* | *Inch.* | *Inch* | *Pounds* |
| ⅛ and ⅛ | 0 35 | 0 70 | 0 07 | 0 09 | 0 032 | 3 08 |
| 5/32 | 35 | 70 | 07 | 13 | 032 | 4 34 |
| ⅛ | 40 | 80 | 10 | 17 | 042 | 6 26 |
| 5/16 | 80 | 1 60 | 13o | 21 | 052 | 9 09 |
| ⅜ | 80 | 1 20 | 15 | 24 | 062 | 14 50 |
| 7/16 | 70 | 1 40 | 17 | 25 | 032 | 18 88 |
| ½ | 80 | 1 60 | 198 | 30 | 042 | 30 38 |
| 9/16 | 50 | 1 80 | 21 | 35 | 040 | 41 00 |
| ⅝ | 1 00 | 2 00 | 26 | 39 | 060 | 74 00 |

METRIC UNITS

| Size | A | E | C | D | E. | Approximate weight, 1 000 pieces. |
|---|---|---|---|---|---|---|
| | mm | mm | mm | mm | mm | *kg* |
| 1 66 and 2 38 | 8 89 | 17 78 | 1 78 | 2 29 | 0 81 | 1 36 |
| 3 16 | 8 85 | 17 78 | 1 78 | 3 30 | 81 | 1 97 |
| 3 97 | 15 18 | 20 32 | 2 64 | 4 32 | 81 | 2 68 |
| 4 76 | 12 70 | 25 40 | 3 43 | 5 33 | 91 | 4 08 |
| 5 56 | 16 24 | 30 48 | 3 81 | 6 10 | 81 | 5 12 |
| 6 35 | 17 78 | 35 56 | 4 32 | 6 38 | 81 | 7 34 |
| 7 14 | 20 32 | 40 64 | 5 03 | 7 62 | 1 02 | 13 77 |
| 7 94 | 22 86 | 45 72 | 5 33 | 8 35 | 1 02 | 14 97 |
| 9 53 | 25 40 | 50 80 | 6 60 | 9 91 | 1 42 | 33 57 |

Tolerance on dimension A (see Fig 3) shall be + 0 01 in (0.25 mm )

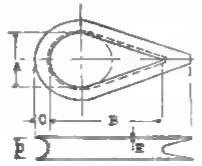



FIG 3

### *3823—Specifications for Medium Carbon Steel Tubes*

GENERAL—1. The general specifications, 1G1 shall form according to their applicability, a part of these specifications

USE.—2 These tubes are suitable for stressed parts, such as braces and tie tubes

MATERIAL—3 The I. A S B standard steel No. 1035 shall be used Its composition is as follows

| | Per cent |
|---|---|
| Carbon | 0 33-0 40 |
| Manganese | 50- 80 |
| Phosphorus, maximum | 045 |
| Sulphur maximum | 050 |

MANUFACTURE—4. (a) The tubes are to be of the cold-drawn seamless type

*Heat Treatment*—(b) The tubes shall be heat treated to give the physical properties specified It is desirable that they be quenched in oil

(c) Any tube may be rejected at any time because of injurious defects or faults in the steel which are revealed by manufacturing operations, notwithstanding the fact that it has previously passed inspection. Such rejected material shall be returned to the manufacturer at the latter's expense This clause shall not apply to materials fabricated after export.

WORKMANSHIP AND FINISH.—5. The tubes are to be smooth, of the section specified, and within the permissible tolerances as to wall thickness, of uniform diameter free from scale, dirt, specks longitudinal seaming lamination grooving, and blistering, both internally and externally

PHYSICAL PROPERTIES AND TESTS—6 The tubes shall have the following physical properties

*Tensile Test*—(a)

Minimum tensile strength, 85 000 lb per square in. (59 24 kg /mm²)
Minimum yield point, 60,000 lb per square in (42 18 kg./mm²)
Minimum elongation, either 20 per cent in 2 in (50 8 mm ) or 12 per cent in 8 in. (203 2 mm )

*Crushing Test*—(b) The test specimen shall be crushed endwise until the outside diameter is increased in one zone by 25 per cent, or until one complete fold is formed The specimen shall stand this treatment without cracking

SELECTION OF TEST SPECIMENS—7 One test specimen for the tensile test shall be chosen from every 400 ft (121 9 m ) of tubing and one test specimen for the crushing test from every 100 ft (30.5 m ) of tubing

The specimens for the crushing tests shall have a length of 1 5 times the diameter of the tube.

Whenever possible the selection of test specimens shall be made by heats

DIMENSIONS AND TOLERANCES—8 (a) The following tolerances will be allowed on the outside diameter of tubes

Tubes under 1 5 in (38 1 mm ) diameter ± 0 003 in (0 08 mm )
Tubes over 1 5 in (38.1 mm.) diameter ± 0 005 in (0 13 mm.)

The manufacturer and purchaser shall agree upon tolerances for coalescent or telescoping tubes

(b) The variation in wall thickness may be ± 10 per cent of the dimension specified

(c) In no part of any tube shall the departure from straightness exceed 1 in 600

DELIVERY, PACKING, AND SHIPPING—9. All tubes shall be well oiled and delivered in boxes not exceeding 220 lb (100 kg ) gross weight

### *3821—Specifications for Welded Steel Tubes*

GENERAL—1 The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

USE.—2 These tubes are suitable only for unstressed parts, such as conduit tubes

MATERIAL—3 The I A, S B standard steel No 1020 shall be used Its composition is as follows

| | Per cent |
|---|---|
| Carbon | 0.15-0.25 |
| Manganese | 30- 60 |
| Phosphorus maximum | 045 |
| Sulphur maximum | 050 |

MANUFACTURE—4. All tubes shall be of the welded type. They must be carefully annealed before the final pass

Any tube may be rejected at any time because of injurious defects or faults in the steel which are revealed by manufacturing operations, notwithstanding the fact that it has previously passed inspection. Such rejected material shall be returned to the manufacturer at the latter's expense This clause shall not apply to materials fabricated after export.

WORKMANSHIP AND FINISH.—5 The tubes are to be smooth of the section specified and within the permissible tolerances as to wall thickness, of uniform diameter free from scale, dirt specks, longitudinal seaming lamination, grooving and blistering, both internally and externally

PHYSICAL PROPERTIES AND TESTS—6 The tubes shall have the following physical properties

*Tensile Test*—(a)

Minimum tensile strength, 110 000 lb per sq in (77 34 kg /mm²)
Minimum yield point, 80,000 lb. per sq in. (56 27 kg. /mm.²)
Minimum elongation, 15 per cent in 2 in (50 8 mm ) or 8 per cent in 8 in. (203 2 mm.)

FLATTEN 2

Minimum ultimate strength 85,000 lb per sq. in (59 76 kg./mm.²)
Minimum yield point, 60 000 lb per sq in (42 18 kg /mm²)
Minimum elongation, 25 per cent in 4 in (50 8 mm ) or 10 per cent in 8 in (203 2 mm )

*Crushing Test*—(b) The test specimen shall be crushed endwise until the outside diameter is increased in one zone by 25 per cent or until one complete fold is formed The specimen must stand this treatment without cracking.

SELECTION OF TEST SPECIMENS—7 One test specimen for the tensile test shall be chosen from every 400 ft. (121.9 m ) of tubing and one test specimen for the crushing test from every 100 ft. (30.5 m ) of tubing.

The specimens for the crushing tests shall have a length of 1.5 times the diameter of the tube.

Whenever possible the selection of test specimens shall be made by heats.

DIMENSIONS AND TOLERANCES—8 (a) The following tolerances will be allowed on the outside diameter of tubes

Tubes under 1 5 in. (38 1 mm.) diameter, ± 0 003 in (0 08 mm.)
Tubes over 1 5 in (38 1 mm.) diameter, ± 0 005 in (0 13 mm.)

(b) The variation in wall thickness may be ± 10 per cent of the dimension specified

(c) In no part of any tube shall the departure from straightness exceed 1 in 600

DELIVERY, PACKING, AND SHIPPING—9 All tubes shall be well oiled and delivered in boxes not exceeding 220 lb. (100 kg ) gross weight.



### CHEMICAL COMPOSITION OF STANDARD ALLOY STEELS

NICKEL STEELS.

| No. | Carbon. | Manganese | Phosphorus maximum | Sulphur maximum. | Nickel | Chromium. |
|---|---|---|---|---|---|---|
| 2320 | 15- 25 | 50- 80 | 040 | 045 | 3 25-3 75 | |
| 2325 | 20- 30 | 50- 80 | 040 | 045 | 3 25-3 75 | |
| 2330 | 25- 35 | 50- 80 | 040 | 045 | 3 25-3 75 | |

CHROMIUM VANADIUM STEELS

| No | Carbon | Manganese. | Phosphorus maximum | Sulphur maximum | Chromium. | Vanadium, minimum |
|---|---|---|---|---|---|---|
| 8120 | 0 15-0 25 | 0 30-0 80 | 0 040 | 0 045 | 0 50-0 80 | 0 15 |
| 8130 | 25- 35 | 50- 80 | 040 | 045 | 80-1 10 | 15 |

### *4P1—Specifications for Turnbuckles*

GENERAL.—1 The general specifications, 1G1, shall form, according to their applicability a part of these specifications

MATERIAL.—2. Barrels shall be made of naval brass or equivalent alloy, I A S B. specifications 3N4 The shanks shall be made of steel, I A S B specifications 3S4

PHYSICAL PROPERTIES AND TESTS.—3. (a) At least 2 per cent of all turnbuckles shall be subjected to the test load given in the table and must withstand this test

Steel turnbuckle shanks shall be heat treated to withstand the test loads specified

(b) A bent test shall be made upon a (minimum) shank of each turnbuckle tested in tension the shank must withstand bending through 90 deg without cracking

DIMENSIONS AND TOLERANCES.—4 Dimensions and tolerances are given in the tables following

When electric or crucible furnace steel is specified in the order the maximum allowable percentages of phosphorus and sulphur may, at the option of the purchaser be limited to 0.03 per cent.

ASSEMBLY.—5. The threads are to be greased and must have a snug true fit allowing the barrel or shank to be turned by hand and showing absolutely no slackness in fit or perceptible end shake when the ends have been extended three threads from the barrel.

FINISH.—6. Turnbuckle shanks shall be thoroughly covered with a suitable non corrosive grease before shipment Before inspection of the finished turnbuckles they may, if so specified, be copper plated in order that initial stress in the barrel may be detected After this inspection turnbuckles shall be greased or shall be coated with an air-drying enamel as specified

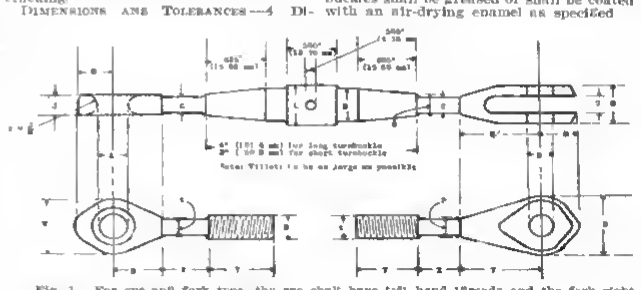



FIG. 1—For eye and fork type the eye shall have left hand threads and the fork right hand threads, for double eye type, one end shall have left hand threads and the other right hand threads.

DIMENSIONS IN INCHES

| Cable No. | Strength in pounds | Eye end C +0.001 −0.002 | F | Eye end X +0.005 −0.005 | Eye end Y −0.010 −0.000 | Eye end A +0.110 0.000 | Eye end B −0.005 −0.115 | Eye end J +0.005 0.000 | Eye end K 0.005 −0.005 | Eye end R +0.005 −0.005 | Eye end W +0.010 −0.000 | Fork end B +0.005 −0.005 | Fork end H +0.005 −0.000 | Fork end F +0.010 −0.000 | Fork end G +0.015 −0.000 | Fork end H +0.005 −0.005 | Fork end I +0.005 −0.005 | Fork end P +0.010 −0.010 | Fork end S +0.005 −0.005 | Barrel T +0.005 −0.005 | Barrel L +0.005 −0.005 | Barrel M +0.005 −0.005 | Barrel N +0.005 −0.005 | Threads per inch, U. S. standard |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 A | 1 500 | 0.130 | 0.203 | 0.500 | 0.380 | 0.110 | 0.115 | 0.188 | 0.210 | 0.281 | 0.500 | 0.188 | 0.188 | 0.111 | 0.110 | 0.300 | 0.210 | 0.301 | 0.500 | 0.371 | 0.281 | 0.203 | 0.203 | 28 |
| 1 B | 1 500 | 130 | 208 | 1 531 | 506 | 211 | 2 0 | 188 | 210 | 281 | 500 | 188 | 188 | 111 | 110 | 300 | 210 | 301 | 500 | 375 | 281 | 208 | 208 | 28 |
| 1 C | 1 500 | 130 | 208 | 560 | 560 | 211 | 250 | 188 | 210 | 281 | 500 | 188 | 188 | 111 | 110 | 300 | 210 | 301 | 500 | 375 | 281 | 208 | 208 | 28 |
| 1 D | 1 500 | 130 | 208 | 1 531 | 508 | 211 | 2 0 | 188 | 210 | 281 | 500 | 188 | 188 | 111 | 110 | 300 | 210 | 301 | 500 | 375 | 281 | 208 | 208 | 28 |
| 2 A | 2 150 | 157 | 203 | 500 | 563 | 211 | 188 | 188 | 210 | 313 | 500 | 313 | 188 | 111 | 110 | 138 | 210 | 300 | 625 | 375 | 328 | 241 | 241 | 24 |
| 2 B | 2 150 | 157 | 203 | 1 531 | 563 | 210 | 328 | 188 | 210 | 313 | 500 | 138 | 188 | 311 | 110 | 500 | 211 | 300 | 867 | 375 | 328 | 241 | 241 | 24 |
| 2 C | 2 150 | 157 | 208 | 560 | 563 | 211 | 188 | 188 | 210 | 313 | 500 | 313 | 188 | | | | | | | 375 | 328 | 241 | 241 | 24 |
| 2 D | 2 150 | 157 | 203 | 1 531 | 563 | 211 | 328 | 188 | 210 | 313 | 500 | 138 | 188 | | | | | | | 375 | 328 | 241 | 241 | 24 |
| 3 A | 3 000 | 185 | 234 | 500 | 625 | 281 | 391 | 219 | 240 | 375 | 625 | 391 | 219 | 111 | 110 | 641 | 240 | 621 | 811 | 433 | 391 | 311 | 311 | 24 |
| 3 B | 3 000 | 185 | 234 | 1 375 | 625 | 281 | 391 | 219 | 240 | 500 | 625 | 391 | 219 | 111 | 110 | 775 | 240 | 621 | 811 | 433 | 391 | 311 | 311 | 24 |
| 3 C | 3 000 | 185 | 234 | 500 | 625 | 281 | 701 | 219 | 240 | 375 | 625 | | | | | | | | | 433 | 391 | 311 | 311 | 24 |
| 3 D | 3 000 | 185 | 234 | 1 375 | 625 | 281 | 391 | 219 | 240 | 500 | 625 | | | | | | | | | 433 | 391 | 311 | 311 | 24 |
| 4 A | 4 000 | 213 | 265 | 500 | 688 | 311 | 422 | 250 | 281 | 500 | 688 | 422 | 250 | 156 | 156 | 813 | 281 | 881 | 811 | 500 | 438 | 344 | 344 | 20 |
| 4 B | 4 000 | 213 | 265 | 1 250 | 688 | 311 | 422 | 250 | 281 | 500 | 688 | 422 | 250 | 156 | 281 | 813 | 281 | 881 | 811 | 500 | 438 | 344 | 344 | 20 |
| 4 C | 4 000 | 213 | 265 | 500 | 688 | 311 | 125 | 250 | 281 | 500 | 688 | | | | | | | | | 500 | 438 | 344 | 344 | 20 |
| 4 D | 4 000 | 213 | 265 | 1 250 | 688 | 311 | 125 | 250 | 281 | 500 | 688 | | | | | | | | | 500 | 438 | 344 | 344 | 20 |
| 5 A | 5 750 | 256 | 313 | 500 | 750 | 311 | 469 | 281 | 313 | 563 | 750 | 469 | 281 | 161 | 161 | 938 | 313 | 1 063 | 1 250 | 531 | 484 | 378 | 378 | 18 |
| 5 B | 5 750 | 256 | 313 | 1 250 | 750 | 313 | 469 | 281 | 313 | 563 | 750 | 469 | 281 | 161 | 281 | 938 | 313 | 1 063 | 1 250 | 531 | 484 | 378 | 378 | 18 |
| 5 C | 5 750 | 256 | 313 | 500 | 750 | 313 | 156 | 281 | 313 | 563 | 750 | | | | | | | | | 531 | 484 | 378 | 378 | 18 |
| 5 D | 5 750 | 256 | 313 | 1 250 | 750 | 313 | 469 | 281 | 313 | 563 | 750 | | | | | | | | | 531 | 484 | 378 | 378 | 18 |
| 6 A | 8 400 | 318 | 375 | 500 | 875 | 411 | 500 | 313 | 375 | 625 | 875 | 500 | 313 | 161 | 161 | 938 | 375 | 1 063 | 1 250 | 625 | 594 | 469 | 469 | 16 |
| 6 B | 8 400 | 318 | 375 | 1 125 | 875 | 411 | 500 | 313 | 375 | 625 | 875 | 500 | 313 | 161 | 281 | 938 | 375 | 1 063 | 1 250 | 625 | 594 | 469 | 469 | 16 |
| 6 C | 8 400 | 318 | 375 | 500 | 875 | 411 | 188 | 313 | 375 | 625 | 875 | | | | | | | | | 625 | 594 | 469 | 469 | 16 |
| 6 D | 8 400 | 318 | 375 | 1 125 | 875 | 411 | 500 | 313 | 375 | 625 | 875 | | | | | | | | | 625 | 594 | 469 | 469 | 16 |

a When a turnbuckle has two eye ends with different size holes for the pin and cable, the two diameters are given
b The turnbuckle is to be bored to receive pin on one end only

DIMENSIONS IN MILLIMETERS

| Cable No. | Strength in kilograms | Eye end C −0.03 −.08 | Eye end E | Eye end X +0.13 −.13 | Eye end Y +0.25 −.00 | Eye end A +0.05 −.00 | Eye end B +0.13 −.13 | Fork end J +0.13 −.08 | Fork end K +0.13 −.13 | Fork end R +0.13 −.13 | Fork end W +0.13 −.13 | Fork end B +0.13 −.13 | Fork end D +0.05 −.00 | Fork end F +0.38 −.00 | Fork end G +0.38 −.00 | Fork end H +0.1 .13 | Fork end I +0.13 −.13 | Fork end S +0.13 −.13 | Barrel T +0.13 −.13 | Barrel L +0.13 −.13 | Barrel M +0.12 −.13 | Barrel N +0.13 −.11 | Threads per inch, U. S. standard |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 A | 680.4 | 3.30 | 5.16 | 12.70 | 12.70 | 5.56 | 8.33 | 4.78 | 5.56 | 7.11 | 12.70 | 6.99 | 3.07 | 7.04 | 3.71 | 7.62 | 5.56 | 12.70 | 14.29 | 9.53 | 7.14 | 5.28 | 26 |
| 1 B | 680.4 | 3.30 | 5.16 | 38.89 | 12.70 | 5.56 | 8.33 | 4.78 | 5.56 | 7.11 | 12.70 | 6.99 | 3.07 | 7.04 | 3.71 | 7.62 | 5.56 | 12.70 | 14.29 | 9.53 | 7.14 | 5.28 | 26 |
| 1 C | 680.4 | 3.30 | 5.16 | 12.70 | 12.70 | 5.56 | 8.33 | 4.78 | 5.56 | 7.11 | 12.70 | | | | | | | | | 9.53 | 7.14 | 5.28 | 26 |
| 1 D | 680.4 | 3.30 | 5.16 | 38.89 | 12.70 | 5.56 | 8.33 | 4.78 | 5.56 | 7.14 | 12.70 | | | | | | | | | 9.53 | 7.14 | 5.28 | 26 |
| 2 A | 975.2 | 3.99 | 5.16 | 12.70 | 14.29 | 5.56 | 8.33 | 4.78 | 5.56 | 7.94 | 12.70 | 8.33 | 4.78 | 7.11 | 3.71 | 11.11 | 5.56 | 12.70 | 15.88 | 9.53 | 8.33 | 6.1 | 30 |
| 2 B | 975.2 | 3.99 | 5.16 | 38.89 | 14.29 | 5.56 | 8.33 | 4.78 | 5.56 | 7.94 | 12.70 | 8.33 | 4.78 | 7.11 | 3.71 | 11.11 | 5.56 | 12.70 | 17.46 | 9.53 | 8.33 | 6.1 | 30 |
| 2 C | 975.2 | 3.99 | 5.16 | 12.70 | 14.29 | 5.56 | 8.33 | 4.78 | 5.56 | 7.94 | 12.70 | | | | | | | | | 9.53 | 8.33 | 6.1 | 30 |
| 2 D | 975.2 | 3.99 | 5.16 | 38.89 | 14.29 | 5.56 | 8.33 | 4.78 | 5.56 | 7.94 | 12.70 | | | | | | | | | 9.53 | 8.33 | 6.1 | 30 |
| 3 A | 1361 | 4.70 | 5.95 | 12.70 | 15.88 | 7.14 | 9.92 | 5.56 | 6.35 | 9.53 | 15.88 | 9.92 | 5.56 | 7.94 | 3.71 | 14.29 | | 11.98 | 20.64 | 11.51 | 9.92 | 7.94 | 26 |
| 3 B | 1361 | 4.70 | 5.95 | 31.93 | 15.88 | 7.11 | 9.92 | 5.56 | 6.35 | 10.31 | 15.88 | 9.92 | 5.56 | 7.94 | 3.71 | 14.29 | 6.45 | 13.88 | 20.64 | 11.51 | 9.92 | 7.94 | 26 |
| 3 C | 1361 | 4.70 | 5.95 | 12.70 | 15.88 | 7.11 | 9.92 | 5.56 | 6.11 | 9.53 | 15.88 | | | | | | | | | 11.43 | 9.92 | 7.94 | 26 |
| 3 D | 1361 | 4.70 | 5.95 | 31.93 | 15.88 | 7.11 | 9.01 | 5.56 | 6.11 | 10.37 | 15.88 | | | | | | | | | 11.61 | 9.92 | 7.94 | 26 |
| 4 A | 1814 | 5.11 | 6.73 | 12.70 | 17.46 | 8.73 | 10.72 | 6.35 | 7.14 | 12.70 | 17.46 | 10.72 | 6.35 | 11.11 | 5.16 | 15.88 | 7.11 | 17.46 | 22.23 | 12.70 | 11.11 | 9.53 | 26 |
| 4 B | 1814 | 5.11 | 6.73 | 31.75 | 17.46 | 8.73 | 10.72 | 6.35 | 7.11 | 12.70 | 17.46 | 10.72 | 6.35 | 11.11 | 5.16 | 15.88 | 7.11 | 17.46 | 22.23 | 12.70 | 11.11 | 9.53 | 26 |
| 4 C | 1814 | 5.11 | 6.73 | 12.70 | 17.46 | 8.73 | 10.72 | 6.35 | 7.14 | 12.70 | 17.46 | | | | | | | | | 12.70 | 11.11 | 9.53 | 26 |
| 4 D | 1814 | 5.11 | 6.73 | 31.75 | 17.46 | 8.73 | 10.72 | 6.35 | 7.14 | 12.70 | 17.46 | | | | | | | | | 12.70 | 11.11 | 9.53 | 26 |
| 5 A | 2608 | 6.60 | 7.91 | 12.70 | 19.01 | 7.91 | 11.91 | 7.11 | 7.91 | 14.29 | 19.05 | 11.11 | | 11.11 | | 15.88 | 7.91 | 19.05 | 22.23 | 13.11 | 12.30 | 11.11 | 24 |
| 5 B | 2608 | 6.60 | 7.94 | 31.75 | 19.05 | 7.94 | 11.91 | 7.14 | 7.91 | 14.29 | 19.05 | 11.91 | 7.14 | 11.29 | 5.16 | 15.88 | 7.91 | 19.05 | 22.23 | 13.11 | 12.30 | 11.11 | 24 |
| 5 C | 2608 | 6.60 | 7.94 | 12.70 | 19.05 | 7.94 | 11.91 | 7.14 | 7.94 | 14.29 | 19.05 | | | | | | | | | 13.49 | 12.30 | 11.11 | 24 |
| 5 D | 2608 | 6.60 | 7.94 | 31.75 | 19.05 | 7.94 | 11.91 | 7.11 | 7.91 | 14.29 | 19.05 | | | | | | | | | 13.49 | 12.30 | 11.11 | 24 |
| 6 A | 3810 | 8.05 | 9.53 | 12.70 | 22.23 | 7.94 | 12.70 | 8.33 | 9.53 | 15.88 | 22.23 | 12.70 | 8.33 | 11.29 | 6.71 | 11.21 | 9.53 | 22.23 | 25.40 | 15.88 | 15.08 | 11.91 | 22 |
| 6 B | 3810 | 8.05 | 9.53 | 28.58 | 22.23 | 7.94 | 12.70 | 8.33 | 9.53 | 15.88 | 22.23 | 12.70 | 8.33 | 11.29 | 6.71 | 11.21 | 9.53 | 22.23 | 25.40 | 15.88 | 15.08 | 11.91 | 22 |
| 6 C | 3810 | 8.05 | 9.53 | 12.70 | 22.23 | 7.94 | 12.70 | 8.33 | 9.53 | 15.88 | 22.23 | | | | | | | | | 15.88 | 15.08 | 11.91 | 22 |
| 6 D | 3810 | 8.05 | 9.53 | 28.58 | 22.23 | 7.94 | 12.70 | 8.33 | 9.53 | 15.88 | 22.23 | | | | | | | | | 15.88 | 15.08 | 11.91 | 22 |

a When a turnbuckle has two eye ends with different size holes for the pin and cable, the two diameters are given
b The turnbuckle is to be bored to receive pin on one end only

NOTE.—In columns marked 1 A. S. E. No. the letters used are for the following names: A short fork and eye turnbuckle B long fork and eye turnbuckle C short double-eye turnbuckle D long double-eye turnbuckle

### 3S15—*Specifications for 7 x 19 Extra Flexible Steel Wire Cable*

GENERAL.—1 (a) This specification covers the finish material and construction of high strength steel wire cable composed of flamed-coated steel wires twisted concentrically around a flamed steel wire center, thus forming a strand and such strands twisted concentrically around a central strand of the same construction forming a cable.

(b) The general specifications 1G1 shall form according to their applicability, a part of these specifications.

MATERIAL.—2 The wire shall be manufactured of either 1 A. S. E. Standard Steel No 1065, No. 1070 or No 1080, the compositions of which are listed below

MANUFACTURE.—3 (a) The steel wires composing the individual strands of cable shall be laid concentrically around the center wire in one layer of 6 wires and another or outer layer of 12 wires with a left hand (counter clockwise) pitch the length of pitch of both layers being of the same length, the cable itself shall be constructed by twisting 6 of these strands composed of 19 wires each around a seven strand of the same construction and material with a right hand (clockwise) pitch or lay of 6 to 8 times the diameter of the whole

It is not to be understood that the strand composing this cable must necessarily be composed of wires of the same diameter

(b) The steel from which the wires composing the cable are drawn shall be manufactured in the acid open hearth process.

(c) Wires composing the cable shall be uniformly coated with pure zinc to solder readily

(d) Joints in wires in cable having a diameter of 0.187 13/100 in (4.76 mm) and larger shall be brazed in a gas fire In cable having a diameter of 0.156 5/32) in (3.97 mm) or less wires may be joined either by brazing or twisting at the manufacturer's convenience Tucked or arc welded joints are not permitted No two joints in individual wires shall be closer to one another in the completed cable than 30 ft (9.14 m)

WORKMANSHIP AND FINISH.—4 Each length of cable is to be evenly laid and free from kinks, loose wires, or other irregularities The cable shall remain in this condition when unwound from the reel or bent around a standard thimble proper precautions being taken to secure the ends.

PHYSICAL PROPERTIES AND TESTS.—*Tensile Test*—5 (a) A tensile test shall be made upon each individual reel of cable purchased of a size

(b) Samples of cable for testing for tensile strength shall be no less than 24 in (610 mm) in length In making tensile tests the distance between jaws of testing machine with sample in place and before test shall be not less than 10 in (254 mm)

(c) Samples for tensile test may be clamped in the jaws of the testing machine in the usual manner to facilitate testing but in case of failure or dispute on individual tests, and at the request of the manufacturer, check tests shall be made by socketing the samples with pure zinc

(d) Cable for use in the construction of aircraft shall meet the required breaking strength specified in this table

*Bend Test*—6 (a) One bend test is to be made on a sample cut from each reel of cable of a given size. Each sample must be bent once around its own diameter and straightened again at least 20 times in succession in the same direction of bending without any of the wires breaking.

*Torsion Test*—7 (a) A torsion test is to be made on one wire from each sample of cable taken for tensile test The wire is to be gripped by two vises 8 in (203 mm.) apart; one vise shall be turned uniformly at as high a rate of speed as possible without perceptibly heating the wire One vise shall have free axial movement in either direction

(b) The number of complete turns which the wire shall stand is determined by the formula

$$\text{Number of turns} = \frac{22}{\text{diameter in inches}} = \frac{559}{\text{diameter in millimeters}}$$

(c) Failure of one piece of wire to show full number of turns specified in the above torsion test shall not be considered cause for rejection but in such case, two additional tests shall be made on two more wires from the same sample of cable and if both samples meet the requirements of the specification the cable shall be accepted in this respect

DIMENSIONS AND TOLERANCES.—8. There shall be no perceptible variation in all under below size. Cable having a diameter of 0.125 (1/8) to 0.187 (3/16) in (3.18 to 4.76 mm.), inclusive shall have a permissible variation of 10 per cent above size and cable having a diameter of 0.218 (7/32) to 0.375 (3/8) in (5.50 to 9.53 mm.) inclusive, shall have a permissible variation of 7 per cent above size

DELIVERY, PACKING AND SHIPPING.—9 (a) All cable shall be shipped on reels in lengths as specified on orders

(b) The dimensions of reels for different lengths and sizes of cable shall conform to the table contained in this specification

(c) A thimble or galvanized steel seal wire of approved design shall pass around no less than 3 convolutions of the cable on the reel and shall pass through a thimble tag showing the name of the manufacturer the size and length of cable on the reel the order number or other identifying marks and a record of the test for tensile strength A lead seal impressed with the official stamp of the representative of the Government making the inspection shall secure the ends of this seal wire and furnish evidence of inspection and acceptance

(d) The outer layers of cable on a reel ready for shipment shall be protected from mechanical injury in handling and transportation by an efficient covering of burlap.



CHEMICAL COMPOSITION OF STANDARD CARBON STEELS

| Number | Carbon | Manganese | Phosphorus maximum | Sulphur maximum |
|---|---|---|---|---|
| 1065 | 0 60–0 70 | 0 60 to 70 | 0 040 | 0 040 |
| 1070 | 65– 75 | 50– 70 | 040 | 045 |
| 1080 | 75– 90 | 25– 50 | 040 | 045 |

TABLE OF WEIGHTS, SIZES AND STRENGTH OF CABLE

| Diameter inches. | Approximate breaking strength pounds | Approximate weight pounds per 100 feet | Diameter millimeters | Approximate breaking strength kilograms | Approximate weight kilograms per 100 meters |
|---|---|---|---|---|---|
| 0 375 | 14 400 | 26 45 | 9 525 | 6,532 | 39 36 |
| 344 | 12 200 | 22 33 | 8 731 | 5 670 | 33 83 |
| 312 | 9 800 | 17 71 | 7 935 | 4445 | 26 35 |
| 281 | 8,000 | 14 76 | 7 144 | 3 629 | 21 972 |
| 250 | 7,000 | 12 00 | 6 350 | 3 175 | 17 86 |
| 218 | 5 600 | 9 50 | 5 556 | 2 540 | 14 14 |
| 187 | 4 200 | 6 47 | 4 763 | 1 905 | 9 63 |
| 156 | 2 800 | 4 44 | 3 969 | 1 270 | 6 61 |
| 125 | 2 000 | 2 88 | 3 175 | 907 | 4 29 |

REELS FOR CABLE

ENGLISH UNITS.

| Diameter of strand or cable | Diameter of head | Traverse or distance between heads. | Diameter of barrel | Diameter of arbor hole | Diameter of head | Traverse or distance between heads. | Diameter of barrel | Diameter of arbor hole | Diameter of head | Traverse or distance between heads. | Diameter of barrel | Diameter of arbor hole | Diameter of head | Traverse or distance between heads. | Diameter of barrel | Diameter of arbor hole |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1,000 feet | | | | 3 000 feet | | | | 7 000 feet | | | | 10 000 feet | | | |
| In | In | In | In | In | In | In | In | In | In | In | In | In | In | In | In | In |
| 1/8 | 12 | 4 | 8 | 1¼ | 12 | 4 | 8 | 1¼ | 12 | 4 | 8 | 1¼ | 12 | 4 | 8 | 1¼ |
| 5/32 | 12 | 4 | 8 | 1¼ | 12 | 4 | 8 | 1¼ | 12 | 4 | 8 | 1¼ | 12 | 4 | 8 | 1¼ |
| 3/16 | 14 | 4 | 10 | 1¼ | 14 | 4 | 10 | 1¼ | 16 | 4 | 10 | 1¼ | 16 | 7 | 12 | 1¼ |
| 7/32 | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 7 | 12 | 1¼ |
| 1/4 | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 7 | 12 | 1¼ |
| 9/32 | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 10 | 8 | 1¼ |
| 5/16 | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 10 | 8 | 1¼ |
| 11/32 | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 10 | 8 | 1¼ |
| 3/8 | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 10 | 8 | 1¼ |
| 13/32 | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 10 | 8 | 1¼ |
| 7/16 | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 10 | 8 | 1¼ |
| 15/32 | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 10 | 8 | 1¼ |
| 1/2 | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 10 | 8 | 1¼ |
| 17/32 | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 10 | 8 | 1¼ |
| 9/16 | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 10 | 8 | 1¼ |
| 19/32 | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 10 | 8 | 1¼ |
| 5/8 | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 4 | 12 | 1¼ | 16 | 10 | 8 | 1¼ |

METRIC UNITS.

| Diameter of strand or cable | 90 millimeters | | | | 914 meters | | | | 1,828 meters | | | | 3 048 meters | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Diameter of head | Traverse or distance between heads. | Diameter of barrel | Diameter of arbor hole | Diameter of head | Traverse or distance between heads. | Diameter of barrel | Diameter of arbor hole | Diameter of head | Traverse or distance between heads. | Diameter of barrel | Diameter of arbor hole | Diameter of head | Traverse or distance between heads. | Diameter of barrel | Diameter of arbor hole |
| 1 794 | 305 | 102 | 203 | 38 | 305 | 102 | 203 | 38 | 305 | 102 | 203 | 38 | 406 | 102 | 254 | 38 |
| 1 588 | 305 | 102 | 203 | 38 | 305 | 102 | 203 | 38 | 406 | 102 | 254 | 38 | 406 | 102 | 254 | 38 |
| 1 984 | 305 | 102 | 203 | 38 | 406 | 102 | 254 | 38 | 406 | 178 | 305 | 38 | 406 | 178 | 305 | 38 |
| 2 381 | 406 | 102 | 203 | 38 | 406 | 102 | 254 | 38 | 406 | 178 | 305 | 38 | 406 | 178 | 305 | 38 |
| 2 778 | 406 | 102 | 254 | 38 | 406 | 102 | 254 | 38 | 406 | 178 | 305 | 38 | 406 | 254 | 305 | 38 |
| 3 175 | 406 | 102 | 254 | 38 | 406 | 178 | 305 | 38 | 406 | 178 | 305 | 38 | 406 | 254 | 305 | 38 |
| 3 572 | 406 | 178 | 305 | 38 | 406 | 178 | 305 | 38 | 406 | 178 | 305 | 38 | 406 | 254 | 305 | 38 |
| 3 969 | 406 | 178 | 305 | 38 | 406 | 178 | 305 | 38 | 406 | 178 | 305 | 38 | 406 | 254 | 305 | 38 |
| 4 366 | 406 | 178 | 305 | 38 | 406 | 254 | 305 | 38 | 406 | 254 | 305 | 38 | 406 | 254 | 305 | 38 |
| 4 763 | 457 | 178 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 |
| 5 159 | 457 | 178 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 |
| 5 556 | 457 | 178 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 |
| 5 953 | 457 | 178 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 |
| 6 350 | 457 | 178 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 |
| 6 747 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 |
| 7 144 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 |
| 7 541 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 |
| 7 938 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 |
| 8 731 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 |
| 9 525 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 |

| Diameter of strand or cable | 914 meters | | | | 1,828 meters | | | | 3 048 meters | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Diameter of head | Traverse or distance between heads. | Diameter of barrel | Diameter of arbor hole | Diameter of head | Traverse or distance between heads. | Diameter of barrel | Diameter of arbor hole | Diameter of head | Traverse or distance between heads. | Diameter of barrel | Diameter of arbor hole |
| | 1,000 meters | | | | 2 000 meters | | | | 3 000 meters | | | |
| 1 794 | 305 | 102 | 203 | 38 | 305 | 102 | 203 | 38 | 305 | 102 | 203 | 38 |
| 1 588 | 305 | 102 | 203 | 38 | 305 | 102 | 203 | 38 | 406 | 102 | 254 | 38 |
| 1 984 | 305 | 102 | 203 | 38 | 406 | 102 | 254 | 38 | 406 | 178 | 305 | 38 |
| 2 381 | 406 | 102 | 203 | 38 | 406 | 102 | 254 | 38 | 406 | 178 | 305 | 38 |
| 2 778 | 406 | 102 | 254 | 38 | 406 | 178 | 305 | 38 | 406 | 254 | 305 | 38 |
| 3 175 | 406 | 102 | 254 | 38 | 406 | 178 | 305 | 38 | 406 | 254 | 305 | 38 |
| 3 572 | 406 | 178 | 305 | 38 | 406 | 254 | 305 | 38 | 406 | 254 | 305 | 38 |
| 3 969 | 406 | 178 | 305 | 38 | 406 | 254 | 305 | 38 | 610 | 254 | 305 | 38 |
| 4 366 | 457 | 178 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 610 | 254 | 305 | 38 |
| 4 763 | 457 | 178 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 610 | 254 | 305 | 38 |
| 5 159 | 457 | 178 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 610 | 254 | 305 | 38 |
| 5 556 | 457 | 178 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 610 | 254 | 305 | 38 |
| 5 953 | 457 | 178 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 610 | 254 | 305 | 38 |
| 6 350 | 457 | 178 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 610 | 254 | 305 | 38 |
| 6 747 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 610 | 254 | 305 | 38 |
| 7 144 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 610 | 254 | 305 | 38 |
| 7 541 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 610 | 254 | 305 | 38 |
| 7 938 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 610 | 254 | 305 | 38 |
| 8 731 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 610 | 254 | 305 | 38 |
| 9 525 | 457 | 254 | 305 | 51 98 | 457 | 254 | 305 | 51 98 | 610 | 254 | 305 | 38 |

In making racks for the above reels allow a 4 in. or 102 mm greater width than the traverse specified above

### The Spruce Supply Better

Maj Charles R. Shaw of the equipment division of the Air Service U. S. Army, while refusing to commit himself on a report from Portland, Ore., that only 2,000,000 ft. of spruce is being delivered, as against a monthly requirement of 10,000,000 ft. did say that he took a very optimistic view of the future of the supply and that it is now very encouraging He attributes the improvement very largely to the effective work of Russell Hawkins who was sent to Portland as the representative of the equipment division with instructions to get the spruce.

Some spruce is coming from Alaska and even a small quantity from the forests of North Carolina. Eastern spruce is just as good in quality as Pacific coast spruce but as the trees are smaller it is difficult to get the long sticks Reliance for airplane wood is not entirely on spruce however, as it is being found that yellow fir which is the trade name for the outer portion of the Douglas fir, is well suited for the purpose.

### Stereoscope Picture War Record

The Signal Corps plans to make a stereoscopic picture record of the war for educational purposes. It is hoped persons who buy the necessary high grade matched lenses will make them available for this use by the Government. It is intended to make such sets of pictures of the present war available at cost

The Photographic Division of the Signal Corps is prepared to fit matched pairs of Zeiss or Goerz lenses with focal lengths of from 5½ to 7 in. and matched pairs of wider angle lenses of from 4 to 4¾ in. focal length

# Appropriation of $1,126,654,260 Asked for Aeronautics

*Over one and an eighth billion dollars for aeronautics were asked for in the budget submitted to Congress on its opening day by the Secretary of the Treasury, in addition to the large sum separately listed for the pay of officers and enlisted men. The total requirements are divided as follows:*

| | |
|---|---|
| *Army* | *$1,032,294,260* |
| *Navy* | *94,000,000* |
| *National Advisory Committee for Aeronautics* | *260,000* |
| *Post Office Department* | *100,000* |
| *Total* | *$1,126,654,260* |

*Some of the larger estimates for the Aviation Section of the Army are: Aeronautical salaries and wages, $9,566,800, against an expenditure of $299,742.10 in 1917, lighter than air equipment, $8,151,000, against $2,949,388.27 expended in 1917; airplanes and seaplanes, $235,866,000, against $6,240,634.55 expended in 1917; spare parts and accessories, $47,173,200, against $752,930.96 expended in 1917; extra engines and spare parts, $553,289,120, against $1,367,110.95 expended in 1917; maintenance, upkeep and operation of aero squadrons, $20,950,000, against $1,249,120.62 expended in 1917; aero stations, $30,240,000; maintenance, repair, etc., of buildings in Europe and purchase of land, $25,827,000; aviation clothing equipment, $1,358,440; development of new types of airplanes and engines, $2,000,000, against an expenditure of $70,462.39 in 1917; schools of military aeronautics, $8,050,000; machine guns for airplanes, $77,475,000, and photographic equipment, materials, etc., $3,405,500.*

*Of the $94,000,000 asked for the Navy, $93,000,000 is for equipment, material, etc., in comparison with an expenditure of $5,075,069.79 in 1917.*

*Among the items asked for the National Advisory Committee for Aeronautics are $65,000 for a large wind-tunnel building and its equipment, and $14,000 for the purchase, maintenance and operation of an airplane, while $100,000 is asked for the Post Office Department for an experimental airplane service.*

*Below are given in detail the separate requests as printed in the budgets:*

### *The Army*

For expenses of the Signal Service of the Army, as follows: Purchase, equipment, and repair of field electric telegraphs, radio installations, signal equipments and stores, binocular glasses, telescopes, heliostats, and other necessary instruments, including necessary meteorological instruments for use on target ranges, motorcycles and motor-driven vehicles used for technical and official purposes, professional and scientific books of reference, pamphlets, periodicals, newspapers and maps for use in the office of the Chief Signal Officer; war balloons and airships and accessories, including their maintenance and repair; telephone apparatus (inclusive of exchange service) and maintenance of the same; electrical installations and maintenance at military posts, fire-control and direction apparatus and material for Field Artillery; maintenance and repair of military lines and cables, including salaries of civilian employes, supplies, general repairs, reserved supplies, and other expenses connected with the duty of collecting and transmitting information for the Army by telegraph or otherwise (acts May 12, 1917, vol. 40, p. 42, sec. 1; June 15, 1917, vol. 40, p. 187, sec. 1; Oct. 6, 1917, vol. 40, p. 355, sec. 1) $1,138,240,314.77.*

*Provided, however*, That no more than $1,032,294,260 of the foregoing appropriation shall be used for the purchase, manufacture, maintenance, repair and operation of airships and other aerial machines, including instruments and appliances of every sort and description necessary for the operation, construction or equipment of all types of aircraft, including guns, armament, ammunition, and all necessary spare parts and equipment connected therewith, and all necessary buildings for equipment and personnel in the Aviation Section and for the purchase, maintenance, repair, and operation, through the Chief Signal Officer of the Army, of all motor propelled passenger and equipment carrying vehicles which may be necessary for the Aviation Section of the Signal Corps.

And also for the establishment, equipment, maintenance and operation of aviation stations, including (a) the acquisition of land, or any interest in land, with any buildings and improvements thereon, by purchase, lease, donation, condemnation or otherwise. *Provided*, That by order of the President any unappropriated or reserved public lands may be reserved from entry, designated and used for such aviation stations; (b) the improvement of such land by clearing, grading, draining, seeding and otherwise making the same suitable for the purpose intended; (c) the construction, maintenance, and repair of permanent or temporary barracks, quarters, hospitals, mess houses, administration, instructional, and recreational buildings, hangars, magazines, storehouses, sheds, shops, garages, boathouses, docks, radio stations, laboratories, observation stations, and all other buildings and structures necessary or advisable; (d) procuring and introducing water, electric light and power, telephones, telegraph, and sewerage to aviation stations and buildings and structures thereon by the extension of existing systems or the creation of new systems and their maintenance, operation and repair, installation of plumbing, electric fixtures, and telephones, fire apparatus and fire-alarm systems and the maintenance, operation and repair of all such systems, fixtures and apparatus; (e) construction and repair of roads, walks, sea walls, breakwaters, bridges, and wharves, dredging, filling, and otherwise improving land and water sites; (f) purchase of stoves and other cooking and heating apparatus, kitchen and tableware, and furniture and equipment for kitchens, mess halls, offices, quarters, barracks, hospitals, and other buildings, screens, lockers, refrigerators, and all other necessary equipment; (g) purchase of gasoline, oil, fuel and all supplies of every kind and character necessary or advisable for maintenance and operation of aviation stations, including electric light and power, telephones, water supply and sewerage service; (h) purchase and manufacture and installation of all kinds of machinery, tools, material, supplies, and equipment for construction, maintenance, and repair of aircraft buildings and improvements at aviation stations, or property or appliances used in connection with aviation.

And also for the purchase or manufacture and issue of special clothing, wearing apparel, and similar equipment for aviation purposes.

And also for the actual and necessary expenses of officers, enlisted men and civilian employes of the Army and authorized agents sent on special duty at home and abroad for aviation purposes, including observation and investigation of foreign military operations and organization, manufacture of aircraft, and engines; also special courses in foreign aviation schools and manufacturing establishments, to be paid upon certificates of the Secretary of War certifying that the expenditures are necessary for military purposes.

And also, for vocational training, including employment of necessary civilian instructors in important trades related to aviation, purchase of tools, equipment, materials and machines required for such training, purchase of textbooks, books of reference, scientific and professional papers, periodicals and magazines, and instruments and material for theoretical and practical instruction at aviation schools and stations, and all other means to carry out the provisions of section 27 of the act approved June 3, 1916, authorizing, in addition to the military training of soldiers while in active service, means for securing educational and vocational training of a character to increase their military efficiency and enable them to return to civil life better equipped for industrial, commercial, and general business occupations.

Also to pay such civilian employes as may be necessary, and for the payment of their traveling and other necessary expenses.

*Provided*, That hereafter mileage to officers in the Aviation Section of the Signal Corps and officers of the Officers' Reserve Corps of the Aviation Section of the Signal Corps traveling on duty in connection with the Aviation Service, shall be paid from the appropriation for the work in connection with which the travel is performed.

And also, for the payment of all expenses in connection with the development of suitable types of aviation engines, airplanes, and other aircraft appurtenances, including the cost of sample engines, airplanes, and appurtenances, cost of any patents and other rights therein, and costs of investigation, experimentation, and research in respect thereto.

And also for the payment of all expenses in connection with the creation, expansion, acquisition, and development of plants, factories, and establishments for the manufacture of airplanes, aircraft, engines, and appurtenances, including provision for the purchase or lease of land with the buildings thereon, construction of permanent or temporary buildings for all purposes, purchase of machinery, tools, and employment of operatives, together with all administrative expenses necessary, the purchase and supply of raw and semifinished materials and of fuel and all other things necessary for creating and extending the production of airplanes, aircraft, engines, and all appurtenances.

And also for creating, maintaining, and operating at technical schools and colleges courses of instruction for aviation students, including cost of instruction, equipment, and supplies necessary for instruction and subsistence of students while receiving such instruction.

*Provided*, That subject to the approval of the Secretary of War, motor propelled vehicles, airplanes, engines, parts thereof, and appurtenances may be exchanged in part payment for new equipment of the same or similar character to be used for the same purpose as those proposed to be exchanged.

*Provided further*, That during the present emergency, officers and enlisted men of foreign armies attached to the Aviation Section of the Signal Corps as instructors or inspectors when traveling in the United States on official business pertaining to the Aviation Section of the Signal Corps shall be authorized, from funds appropriated in this act, the same mileage and transportation allowances as are authorized for officers or enlisted men of the Regular Army.

AVIATION SECTION—AERONAUTICAL SALARIES

| Employes. | Per | Rate | Estimated, 1919 Number | Expended, 1917 Number |
|---|---|---|---|---|
| Salaries | annum | $7,400.00 | 4 | 1 |
| Instructors in flying | do | 7,200.00 | 4 | 1 |
| Do | do | 4,800.00 | 32 | 8 |
| Do | do | 4,200.00 | 24 | 8 |
| Do | do | 3,000.00 | 92 | 23 |
| Do | do | 1,500.00 | 24 | 6 |
| Do | do | 1,200.00 | 196 | 42 |
| Do | do | 900.00 | 8 | 2 |
| Instructors in ballooning | do | 4,800.00 | 4 | 1 |
| Do | do | 4,000.00 | 4 | 1 |
| Do | do | 3,600.00 | 4 | 1 |
| Do | do | 2,400.00 | 4 | 1 |
| Aeronautical mechanics | do | 4,800.00 | 4 | 1 |
| Do | do | 4,000.00 | 4 | 1 |
| Do | do | 3,600.00 | 16 | 4 |
| Do | do | 3,000.00 | 12 | 7 |
| Do | do | 2,700.00 | 24 | 3 |
| Do | do | 2,700.00 | 4 | 1 |
| Do | do | 2,400.00 | 36 | 9 |
| Do | do | 2,100.00 | 8 | 2 |
| Do | do | 1,800.00 | 44 | 11 |
| Do | do | 1,500.00 | 32 | 8 |
| Do | do | 1,200.00 | 4 | 1 |
| Do | do | 1,000.00 | 4 | 1 |
| Do | do | 1,200.00 | | 3 |
| Inspectors of airplanes and airplane engines | do | 3,000.00 | 10 | 1 |
| Do | do | 2,400.00 | 40 | 8 |
| Do | do | 2,100.00 | | 9 |
| Do | do | 2,000.00 | 100 | 3 |
| Do | do | 1,800.00 | | 1 |
| Do | do | 1,800.00 | 1,500 | 44 |
| Do | do | 1,600.00 | 800 | 2 |
| Do | do | 1,000.00 | | 18 |
| Do | do | 1,400.00 | 800 | 1 |
| Do | do | 1,200.00 | 600 | 20 |
| Factory inspectors | do | 2,000.00 | 75 | |
| Do | do | 1,800.00 | 60 | |
| Do | do | 1,400.00 | 148 | |
| Consulting engineer | do | 5,000.00 | | 1 |
| Do | do | 2,300.00 | 2 | |

AVIATION SECTION—AERONAUTICAL SALARIES (Continued)

| Employes. | Per | Rate | Estimated, 1919 Number | Expended, 1917 Number |
|---|---|---|---|---|
| Salaries | annum | 2,400.00 | 6 | |
| Accountant | do | 2,400.00 | 8 | |
| Do | do | 1,800.00 | 10 | 1 |
| Do | do | 1,600.00 | 10 | |
| Clerks | do | 2,000.00 | 6 | |
| Do | do | 1,600.00 | 10 | 1 |
| Do | do | 1,400.00 | 20 | 3 |
| Do | do | 1,300.00 | | 4 |
| Do | do | 1,200.00 | 100 | 10 |
| Do | do | 1,080.00 | | 1 |
| Do | do | 1,020.00 | | 1 |
| Do | do | 1,000.00 | 100 | 41 |
| Bookkeeper | do | 1,600.00 | 10 | 1 |
| Do | do | 1,200.00 | 30 | 1 |
| Draftsmen | do | 1,800.00 | 10 | 1 |
| Do | do | 1,400.00 | 25 | 1 |
| Do | do | 1,200.00 | 25 | 2 |
| Do | do | 1,000.00 | 10 | 2 |
| Do | do | 900.00 | 10 | 1 |
| Final engineer | do | 3,000.00 | 6 | |
| Do | do | 2,000.00 | 8 | |
| Do | do | 1,400.00 | | 1 |
| Photographer | do | 1,400.00 | 8 | |
| Do | do | 1,200.00 | 5 | |
| Military aeronautics | do | 1,800.00 | 4 | 1 |
| Do | do | 1,200.00 | 10 | 3 |
| Production expert | do | 3,000.00 | 6 | |
| Do | do | 2,000.00 | 6 | |
| Do | do | 1,200.00 | | 1 |
| Electrical mechanics | do | 1,200.00 | 20 | 1 |
| Messenger | do | 720.00 | 120 | 1 |
| Watchman | do | 720.00 | 60 | 1 |
| Wages: | | | | |
| Chief packer | do | 1,000.00 | 110 | 1 |
| Packer | do | 840.00 | 90 | 2 |
| Model makers | do | 1,400.00 | 5 | |
| Do | do | 1,000.00 | 10 | |
| Instrument makers | do | 1,800.00 | 3 | |
| Do | do | 1,800.00 | | 1 |
| Do | do | 1,400.00 | 10 | |
| Do | do | 1,200.00 | 10 | |
| Carpenter | do | 1,000.00 | 90 | 1 |
| Chauffeur | do | 720.00 | 130 | 2 |
| Janitor | do | 600.00 | 90 | |
| Laborers | do | 660.00 | 100 | |
| Skilled laborer | do | 720.00 | 50 | |
| Aviation ammunitions | do | 1,800.00 | | 1 |
| Do | do | 1,200.00 | | 25 |
| Do | do | 1,000.00 | | 2 |
| Do | do | 1,020.00 | | 2 |
| Do | do | 1,020.00 | | 7 |
| Do | do | 1,000.00 | | 40 |
| Do | do | 1,200.00 | | 32 |
| Do | do | 1,020.00 | | 2 |
| Do | do | 1,000.00 | | 3 |
| Do | do | 900.00 | | 4 |
| Salaries | | | $9,012,000.00 | $299,793.63 |
| Wages | | | $44,200.00 | $8,848.42 |

OTHER OBJECTS OF EXPENDITURE

| | | |
|---|---|---|
| Lighter than air equipment | $171,000.00 | 278,388.27 |
| Airplanes and seaplanes | 235,866,000.00 | 6,240,634.55 |
| Spare parts and accessories | 47,173,200.00 | 752,930.96 |
| Extra engines and spare parts | 553,289,120.00 | 1,367,110.95 |
| Maintenance, upkeep and operation of aero squadrons | 20,950,000.00 | 1,249,120.62 |
| Aero stations, United States | 30,240,000.00 | |
| Aero stations, Panama | 5,420,000.00 | |
| Aero stations, Hawaii | 4,420,000.00 | |
| Maintenance, repair, etc., buildings in Europe | 3,127,000.00 | |
| Purchase of land | 10,700,000.00 | |
| Warehouse and supply depots | 6,000,000.00 | |
| Aviation clothing equipment | 1,358,440.00 | |
| Expenses of officers, enlisted men, and civilians on special duty | 97,200.00 | |
| Vocational training | 120,000.00 | |
| Mileage to officers and traveling expenses of civilian employees | 3,050,000.00 | |
| Development of new types of airplanes and engines | 2,000,000.00 | 70,462.39 |
| Schools of military aeronautics | 8,050,000.00 | |
| Machine guns for airplanes | 77,475,000.00 | |
| Photographic equipment, material, etc. | 3,405,500.00 | |
| Contingent expenses, office equipment, etc. | 100,000.00 | |
| Construction | | 3,001,263.77 |
| Leasing of land | | 77,012.12 |
| Reserve officers and men | | 400,000.00 |
| Aeronautics, barographs, aviators' garments and other special accessories | | 2,841.45 |
| Miscellaneous | | 358,314.00 |
| Total aviation | $1,032,294,260.00 | $14,158,341.89 |

PAY OF OFFICERS AND MEN

In the budget the pay for officers and men of the Aviation Section is included in that of the Signal Corps. The requests for Signal Corps pay appropriations follow:

SIGNAL CORPS

| | |
|---|---|
| Pay of 11,041 officers | $27,610,530.00 |
| Aviation increase, officers | 10,030,800.00 |
| Additional pay for length of service, officers | 100,000.00 |
| Pay of 183,049 enlisted men | 60,666,867.00 |
| Aviation increase, men | 4,918,800.00 |
| Additional pay for length of service, men | 150,000.00 |
| Total | $103,423,740.05 |

### *The Navy*

For aviation to be expended under the direction of the Secretary of the Navy for procuring, producing, constructing,

* The amount appropriated for the fiscal year ending June 30, 1918, was $66,067,700 and $640,000,000. [The Act of July 24, 1917 (40 Stat. p. 247, Sec. 10) appropriated $640,000,000 for "Increase for Aviation, Signal Corps."]

operating, preserving, storing and handling aircraft; establishment and maintenance of aircraft stations, including the acquisition of land by purchase, donation, or condemnation; and for experimental work in the development of aviation for naval purposes, $34,000,000. *Provided*, That the sum to be paid out of this appropriation under the direction of the Secretary of the Navy for drafting, clerical inspection and messenger service for aircraft stations shall not exceed $361,000 (act 18 Mar. 4, 1917, vol. 39, p. 1109, sec. 3; June 15, 1917, vol. 40, p. 203, sec. 1; 1 Oct. 6, 1917, vol. 40, p. 361, sec. 11, $34,000,000.*

| | Estimated 1919 | Expended 1917 |
|---|---|---|
| Wages | $1,000,000.00 | $292,179.70 |
| Equipment, material, etc. | 10,000,000.00 | 5,571,693.71 |
| Unexpended balances | | 14,122,826.59 |
| Total | $34,000,000.00 | $19,986,700.00 |

*National Advisory Committee for Aeronautics*

For scientific research, technical investigations, and special reports in the field of aeronautics, including the necessary laboratory and technical assistants, traveling expenses of members and employees, rent outside in the District of Columbia, other supplies, printing, and other miscellaneous expenses, equipment, maintenance and operation of research laboratory, and construction of additional buildings necessary in connection therewith; purchase, maintenance, operation, and exchange of necessary airplanes and one motor-propelled passenger-carrying vehicle; clerks, draftsmen, personal services in the field and in the District of Columbia. *Provided*, That the sum to be paid out of this appropriation for clerical, drafting, watchmen, and messenger service for the fiscal year ending June thirtieth, nineteen hundred and nineteen, shall not exceed $20,000. In all (acts Mar. 1, 1915, vol. 38, p. 930, sec. 1; Mar. 4, 1917, vol. 39, p. 1171, sec. 1; Oct. 6, 1917, vol. 40, p. 369, sec. 1), $260,000.**

* The annual appropriated for the fiscal year ending June 30, 1918, was $61,153,000.

** For the fiscal year ending June 30, 1918, $107,000 was appropriated.

| Fiscal years | Rate, estimated, per annum | Employed, 1919 No. | Employed, 1917 No. |
|---|---|---|---|
| Salaries | | | |
| Assistant secretary | $2,500.00 | 1 | |
| Clerk | 1,500.00 | 1 | 1 |
| Stenographer | 1,400.00 | 1 | |
| Stenographer | 1,200.00 | 11 | |
| Do | 1,000.00 | 4 | 3 |
| Technical assistants | 2,500.00 | 2 | |
| Mechanical engineer | 2,400.00 | 1 | |
| Junior mechanical engineer | 1,800.00 | 1 | |
| Do | 1,500.00 | 1 | |
| Aeronautical engineering draftsmen | 1,000.00 | 2 | |
| Assistant physicists | 1,800.00 | 2 | |
| Messenger, laid, and laborers | 840.00–240.00 | 1 | |
| Wages | | | |
| Pattern maker | 1,400.00 | 1 | |
| Machinists | 1,200.00 | 2 | |
| Salaries | | 26.0001 | 27.11 |
| Wages | | 4,000 | |
| Other objects of expenditure | | | |
| Traveling expenses | | 4,000 | 1,200.59 |
| Rent of offices | | 4,000 | 1,200.00 |
| Supplies, printing, and other items of expenses | | 10,000 | 107.30 |
| Scientific research, technical investigation, and special reports | | 97,000 | 8,096.35 |
| Contingent fund of research laboratory | | | 8,948.41 |
| Equipment, maintenance, and operation of laboratory | | 10,000 | |
| Large wind tunnel, building, machinery, and engineering material | | 15,000 | |
| Construction of additional buildings | | 1,000 | |
| Purchase, maintenance, and operation of automobile | | 1,000 | |
| Purchase, maintenance, and operation of airplanes | | 11,000 | |
| | | $260,000 | $20,452.79 |

*Post Office Department*

In the appropriation requested by the Post Office Department authorization is asked for the Postmaster General "to expend not exceeding $100,000 for the purchase, operation and maintenance of airplanes for an experimental airplane mail service between such points as he may desire."

# Annual Report of the Secretary of the Navy

The Secretary of the Navy has made public his annual report for the fiscal year ending June 30, 1917, including operations and recommendations to Dec. 1, 1917.

Secretary Daniels points out that the enormous expansion and development of the Naval Air Service dates from the passage of the Naval Act on Aug. 29, 1916. The appropriations for Naval Aviation Service July 1, 1916, have been $67,633,000. Up to that time naval aviation had been almost entirely in the experimental and development stage, during which every type of seaplane offered by any United States builder had been tried, but none had been found fully satisfactory by the Pensacola Flying School. The organization for aeronautics has been thoroughly overhauled and coordination of all activities needed in developing an adequate air service arranged for by delegating responsibility for its creation to the Chief of Naval Operations and Material Bureaus of the Navy Department.

The flying school at Pensacola was enlarged and reorganized and a supply of seaplanes constructed by a contractor in quantity of a type suitable for instruction and incorporating all known safety features, according to the design outlined by the department, while other builders were encouraged to develop improvements. The department is now able to purchase satisfactory school seaplanes from at least four builders and their supply is now considered adequate to meet the needs of all training stations. Men have also been sent to France, England and Canada for flying instruction.

This development has been badly handicapped by lack of a suitable high powered engine; one builder developed a 200 hp. tractor seaplane, of which quantities were then supplied to coastal air stations. While high grade engines of French design were put into production, they were not of sufficient power for naval work. Only recently has what appears to be the desired engine become available. This is the so-called "Liberty" engine developed by the Aircraft Board, which gives every promise of providing an adequate power plant for service type aircraft. The engine has been installed in a seaplane and in a flying boat and the preliminary tests have been quite satisfactory.

Referring to the flying boat Secretary Daniels states that for sea work, foreign opinion at the present time, as well as our own, strongly favors it. This type is an American conception and it is a satisfaction to be able to state that here, at least, American designs have been well to the front and that it is not necessary to copy foreign patterns in order to insure superiority being supplied with the best, but that the present task of the department is to produce at the earliest practicable time the numbers of these boats needed and to improve the type still further to meet still better the needs of the service.

Speaking of the kite balloons he says that there has been quite a development of towing kite balloons during the year, and that their operation in fair weather presents no great difficulty, but kites in their have proved unable to withstand storm conditions. Improved types of balloons and means for handling are being developed.

Airships or dirigibles of modern European type had never been constructed in the United States, he says, but a design of a coast patrol type was prepared in the department and a number of units have been successfully completed by several companies. A training school for dirigible pilots was established in Ohio, and a number of officers have become skilful operators. Coastal dirigible stations are being established from Massachusetts to Panama.

The commission of special board, headed by Admiral Helm, recommended a submarine and aviation base at Coco Solo, Panama, Colon Harbor, which is well toward completion. The aviation base on North Island, San Diego Harbor, for the joint use of the Army and Navy, will, it is believed, be the largest and most important on the west coast. The following bases have been established: Chatham, Mass.; Montauk Point, Long Island; Rockaway Beach, Long Island; Cape May, at the entrance to the Delaware, Hampton Roads, on the aviation station of the Hampton Roads Operating Base, Miami, Fla.; Pensacola, Fla.; Colon, Panama Canal, and North Island, San Diego, Cal.

This commission also recommended Puget Sound Navy Yard as a location for a home base for submarines and an aviation station, and a submarine and aviation operating base at Eagle Hook, opposite Port Angeles, Wash., and one on the Columbia River.

As a part of the enormous expansion of aircraft production facilities the department undertook to build and equip a naval aircraft factory at the Philadelphia Navy Yard. Within nineteen days from the date that the land was assigned, the factory was erected and the first flying boat keel laid.

# Digest of the Foreign Aeronautical Press

*Aeronautics* (London), Oct. 31, 1917

*The London Defenses and the Last Zeppelin Raid.*—In the course of a discussion in Parliament on the last Zeppelin raid on England Sir George Cave made the following statement in behalf of the government: The raid on Friday night (Oct. 20) appears to have been carried out by ten or more Zeppelins. Of these five only reached the neighborhood of London, the remainder failing entirely to reach their objectives, and leaving the country without causing material damage. Of the five Zeppelins which came near to London four failed to penetrate the London defenses, and did no damage. The remaining Zeppelin drifted over London with her engines shut off and dropped three bombs at intervals, causing loss of life. A number of our airplanes went up, but, owing to the atmospheric conditions, which were most unfavorable both for attack and defense, they were unable to bring matter to action. A number of the raiders drifted over France and four at least have been definitely accounted for by the French forces. Information as to the others is still awaited. The greatest possible credit is due to the French airmen and the anti-aircraft artillery for their splendid performance, but in justice to the British anti-aircraft forces, it should be remembered that the airships they brought down in France were flying by daylight and at a much lower height than that which they kept whilst crossing this country. The government has already announced its intention to launch German towns until an end is put to these cold-blooded attacks by Germany on the civil population of this country. Two such attacks have already been made, and the House may rest assured that the process will be continued until its purpose is attained.

*Aeronautics* (London), Nov. 7, 1917

*The British Air Service.*—Sir Eric Geddes, First Lord of the Admiralty, in the course of a speech in the House of Commons on Oct. 31, made the following reference to the work of the Royal Naval Air Service:

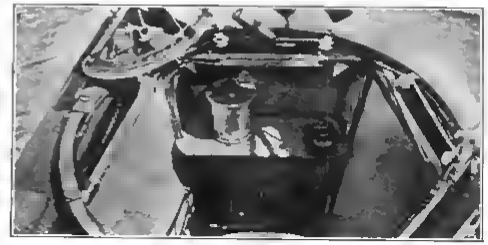
"Since the outbreak of the war the personnel of the Royal Air Service increased from 700 to 41,000. The duties of the Royal Naval Air Service are varied—of great value and of absorbing interest. Its great efficiency and gallantry in France are occasionally brought to public notice by reports of the bombing expeditions and otherwise. But any statement on the Navy would be incomplete without a tribute to the Royal Naval Air Service in operations over the sea. They are the terror of the submarine, and during one month the aircraft patrol around the British coast alone is more than five times the circumference of the earth.

"I think it may interest the House and instruct the public if I give some indication of what the Royal Naval Air Service alone has done in bombing behind the enemy lines in France. During September alone sixty-four raids were carried out on dockyards, naval depots, enemy aerodromes, and other objects of naval and military importance in Flanders behind the enemy lines. No less than 2,736 bombs were dropped by the Royal Naval Air Service alone, totalling 85 tons of explosives. The figures for October are not yet completely tabulated but are still greater. There is no doubt that these raids result in great material and moral damage, and on many occasions their effect is shown in the aerial photographs to be such as to hamper and restrict seriously the enemy naval, aerial, and military undertakings."

In the House of Lords, Earl Curzon paid on Oct. 29 the following tribute to the two branches of the British Air Service:

"I now come to the air service. When we are dealing with the Royal Flying Corps or either of the services, I deliberately say that nowhere in this country has the spirit of knight-errantry been more conspicuously shown. When in August, 1914, 100 officers and 77 machines made their way to France, who could have foreseen that they would have developed into a great fleet of thousands of machines and tens of thousands of men

French Gun Spotter Carrying Radio Apparatus
*Photo Central News Photo Service*



The Radio Set, in the Forward Cockpit
*Photo Central News Photo Service*

On the Western front in the first nine months of 1917 the men of the Royal Flying Corps brought down 876 enemy machines, they drove 759 out of action, 52 were brought down by anti-aircraft gunners, thousands of tons of explosives were dropped on aerodromes, bridges, railways, lines of communication, and area of marching regiments. Apart from offensive operations and activities of the air service, they are the eyes of the Army in the field. Then we must not forget the airmen at home, who have shattered the enemy's Zeppelins, and by their skill and bravery on many occasions have brought those great gasbags in flames to the ground. I sometimes think when Gothas are shrieking over London, and when the civil population are cowering in their cellars we might give a thought to those brave men who are riding in the darkness above and risking their lives to save us from destruction. I include in the same tribute the officers and men of the Naval Air Service. There is no distinction between the two services. At the beginning of the war the personnel of the Naval Air Service was 800, and now it is 42,000. Its fleet in August, 1914, consisted of seven airships, 30 airplanes and 34 seaplanes, whilst the number is now many thousands. The most effective branch of the service has been the naval squadron of Dunkirk, from whence it has bombed aerodromes and has diminished and at times stopped the aerial invasion of our country. These airmen have been in evidence in every theater. They have flown over Damascus, dropped bombs on Beyrout, destroyed buildings in Constantinople, and their flight to the Lake of Constance in the early part of the war and destruction of sheds there will be remembered."

*The Aeroplane* (London), Oct. 24, 1917

*Germany's New Air Program.*—According to Reuter's correspondent with the French Army, the French General Staff has gathered the following information regarding Germany's new air program: The Germans are well aware that some time next year the new American air squadron will come into action on the Western front, and they are already straining every nerve in order to be able to meet the Allied air offensive next spring.

The number of German battleplanes is to be doubled during the coming winter, and the airplanes and motor-building factories throughout Germany are enlarging their plants and obtaining reinforcements of labor to enable them to cope with the sudden influx of orders.

Switzerland is being laid under contribution. Two hundred and fifty Argus motors have been ordered from a firm in the Zurich district.

The Fokker firm, which is building fighting biplanes in great numbers, as well as a triplane remarkable for its speed and climbing powers, has taken over the great Berzina piano factories in Schwerin

For bombing formations heavy three-seated machines are being built which can carry between 1700 and 1800 lb weight of bombs. They have Mercédès 260 hp motors, and when loaded can climb 12,000 ft in 35 min.

In every type of flying machine the Germans are feverishly producing new models for long-distance scouting expeditions. The 1917 Rumpler, with 260 hp Mercédès motor, is said to be the best machine

They are also building a machine, made entirely of metal, to operate in conjunction with infantry on the battlefield It has no great speed, and is a notably slow climber, and does not seem to be able to rise much above 10,000 feet

The enemy is also using a new six cylinder Maybach motor, developing 240 hp, which is lighter than the ordinary Mercédès, and gives greater speed in climbing.

A big German bombing machine which lately landed in Holland was fitted with an electrical installation, driven by the engine, for the purpose of warming the aviator.

During the six months from February to August twenty-nine important industrial establishments were added to the number of factories making airplanes or their accessories in Germany

Simultaneously with this great increase in the output of machines, the Germans are looking everywhere for recruits for the flying service Applications for transfer to the air service are now received from both infantry and engineers, instead of being restricted to cavalry, as was the case not long ago.

Applications are now dealt with in a month instead of two months, and there is no doubt that, in the course of the present year, the personnel of the German air service has been largely reinforced Volunteers are wanted chiefly among the fighting planes, because it is chiefly among the fighting squadrons engaged on the battlefields that casualties occur, but a large number of officers are being trained as observers of observation planes

*Flying* (London), Oct. 24, 1917

*Torpedo Attack by Seaplanes*.—At an early stage of the war the Germans made some experiments with a view to testing the possibility of launching Whitehead torpedoes from Zeppelins. A later development was the sinking of a British merchantman by a torpedo fired from a seaplane on the surface of the water. The practical difficulties to be overcome in designing apparatus which shall relegate to seaplanes the duty of aerial torpedo-boats are by no means insuperable. In its usual form the Whitehead torpedo is too heavy a weapon for any but the largest seaplanes to carry, thus a 21-in torpedo weighs over a ton, while the 18-in size, though somewhat lighter, scales as much as 12 cwt Thus the number of 18-in torpedoes which could be borne by a large seaplane could not be more than two in the case of machines laden with the supply of petrol necessary for a long overseas flight Still, for use against cargo vessels a decidedly smaller explosive charge in the torpedo would have sufficient bursting power to sink the ship and the ability of the seaplane to approach relatively close to its prey might lead to a marked decrease in the necessary propelling machinery in the torpedo Thus as many as four small torpedoes of special type might be carried and, assuming that the airplane approaches to what, for a submarine, would be an impossibly close range, as many as half the torpedoes fired might be expected to strike the ship

As far as general suitability for torpedo attack is concerned, the superiority of the submarine over the seaplane is indisputable, for, armed with its supply of torpedoes, it is prepared equally for attacks upon cargo vessels, transports, or battleships. The seaplane, on the other hand, can carry only a limited number of specially small torpedoes, and probably only a single one of sufficient size to imperil a battleship or cruiser protected by armor-plating. This, of course, raises the question of the possibility of, say, a squadron of airplanes attacking a fleet at sea Such attack would be possible and successful only when based upon the element of surprise such as might be presented at night or in a mist hanging low over the sea Given such conditions, it is conceivable that seaplanes would approach so close to the enemy as to fire a number of torpedoes with some measure of success and probable escape from the storm of shell-fire which their presence, once detected, would call forth On the presence of other airplanes accompanying the fleet in seaplane-ships, the ultimate fate of the attacking aircraft must greatly depend

*Flying* (London), Oct. 31, 1917

*Standardizing the Aero Engine*.—In the fundamental design of a standardized engine technical skill of a higher grade than that found in the ordinary drawing-office routine is essential. Thus there must be no haphazard guessing of the unknown or untried, for the finished drawings will be expected to represent a machine closely fulfilling the requirements laid down by the flying services. The determination of the leading dimensions is based upon factors known empirically or formulated by theories which practice has confirmed, the questions of detail for which the drawing-office will be held responsible, are settled from considerations of strength and ease of manufacture How far the essential condition of provision for minor improvements at a later date can be allowed to vie with efficiency and reduction of labor costs is a matter for the designer's judgment.

The American Government has determined upon producing a super-engine, probably it will not be long before two or three sizes of this engine are under construction For it is manifestly impossible for one engine to serve as the motive unit of all the varied types and sizes of airplanes which the air war demands It is possible, of course, to have one engine for the light scouting machine, to install two such motors in the heavier bombing machine and even three in the largest seaplanes and flying boats But is this desirable? There are arguments against the employment of two air screws in a machine, although, of course, all the largest craft are fitted with two engines—as, for instance, the Handley Page machine, which mounts two enormous engines

The fulfilment of a diversity of purposes will be secured for the aero engine if its construction, even though standardized, is such as to permit of the combination of, say two unit engines to produce one large engine of twice the power This principle is well known in many branches of mechanical engineering and is important even if it involves certain structural difficulties Probably, however, only a special crankshaft and crankcase is required for the duplication in tandem of two "unit" engines to form a double-power engine The valuable feature of standardization, with nearly all the advantages of interchangeability is thereby retained, and by mounting two of these "double" engines in one machine, each driving its own airscrew, we arrive at a system of propulsion suitable for the largest aircraft

There is, thus, much to be said in favor of a standardized airplane engine produced upon a national basis, but first, in our enthusiasm for the merits of this American policy, we lose sight of the disabilities of the system, but remembered that engineering practice is based upon judicious compromise, and a compromise between results which are multiplied up to the present of proved value

CAPTAIN LAURENT'S 300-HP SIA BIPLANE

*Photo Fiat* *Passed by Committee on Public Information*

# News of the Fortnight

## The Aircraft Board Announced

On Dec 7 Howard E Coffin was announced by President Wilson as chairman and Richard F Howe as civilian member of the Aircraft Board Mr Coffin was chairman of the Aircraft Production Board which has been superseded by the Aircraft Board Mr Howe was formerly treasurer of the International Harvester Co One civilian member is still to be appointed

The other members of the Board who previously had been appointed are Maj-Gen George O Squier, Col E A Deeds and Col R L Montgomery, representing the Army, and Rear Admiral D W Taylor, Capt N E Irwin and Lieut.-Com. Arthur K Atkins, representing the Navy

## National Advisory Committee's Appointments

At a recent meeting of the National Advisory Committee for Aeronautics four new committees and a new subcommittee were named, and the committees on foreign representatives, and quarters, having completed their work were discharged The new committees are.

Civil Aerial Transport, Helicopter, or Direct-Lift Aircraft. Free Flight Tests, and Steel Construction for Aircraft. The new subcommittee on Light Alloys will be a branch of the Committee for Standardization and Investigation of Materials

The personnel of all the committees is as follows.

*Aero Torpedos* Lieut-Commander J H Towers, U S N., chairman; Lieut Col V E Clark, U S A

*Aircraft Communications* Dr M I Pupin, Columbia University, chairman; Dr Joseph S Ames, Johns Hopkins University, Dr S W Stratton Director Bureau of Standards, and Dr E D. Ross, Bureau of Standards

*Airplane Mapping* Maj-Gen George O Squier, U S A chairman, Dr Charles D Walcott, secretary of the Smithsonian Institution, secretary, Capt J W Bagley, E R C, and Carl G Fisher

*Bibliography of Aeronautics* Prof Charles F Marvin Chief U S S. Weather Bureau, chairman, and Dr Joseph S Ames.

*Buildings, Laboratories, and Equipment* Dr S W Stratton, chairman Dr Joseph S Ames, Dr W F Durand, Lieut Col V E Clark, Signal Corps, U S A, and Lieut Commander J H Towers, U S N.

*Civil Aerial Transport* Dr W F Durand, chairman, Dr S W Stratton, Prof Charles F Marvin, Lieut-Col V E Clark and Lieut Commander J H Towers, U S N.

*Design, Construction, and Navigation of Aircraft* Maj Gen George O Squier, U S A., chairman, Dr Joseph S Ames Lieut Commander J H Towers, U S N, Lieut Col V E Clark U S A, Dr A F. Zahm, Navy Department secretary, Frederick Alger, Dr M D Hersey and Dr J H Nelson

*Aeronautic Instruments* Dr Joseph S Ames chairman, Commander C T Jewell, U S N, Dr M D Hersey Maj C E Mendenhall, Signal Corps, and Dr Lyman Briggs.

*Editorial* Dr Joseph S Ames chairman Dr S W Stratton and Dr W F Durand

*Free Flight Tests* Prof John F Hayford, chairman, Dr W F Durand Dr S W Stratton, Lieut-Col V E Clark, U S A, Prof. Alexander Klemin, Massachusetts Institute of Technology, Dr Lyman Briggs, Dr A. F. Zahm and Lieut G P Thompson R F C

*Government Relations* Dr Charles D Walcott chairman and Dr S W Stratton

*Helicopter, or Direct-Lift Aircraft* Dr W F Durand, chairman, Dr M I Pupin, M B Sellers, E B Wilson and Dr A F Zahm

*Nomenclature for Aeronautics* Dr Joseph S Ames chairman, Dr S W Stratton, Maj-Gen George O Squier, U S A., Capt. Mark L Bristol, U S N, and Naval Constructor H C Richardson, U S N

*Power Plants* Dr S W Stratton, chairman; Maj-Gen George O Squier, U S A, Dr W F Durand, Lieut.-Commander J H Towers, U S N; Dr H C Dickinson, secretary, Maj Joseph C Riley, Signal Corps, Prof E C Newcomb and Lieut Commander A K Atkins, U S N

*Relation of the Atmosphere to Aeronautics* Prof Charles F. Marvin, chairman, Dr. J S. Ames, Prof J F. Hayford, Lieut Commander J H Towers, U S N., Lieut-Col T DeWitt Milling, U. S A., Prof J C Humphreys and Maj Wm R Blair, Signal Corps.

*Special Committee of Engineering Problems* Dr W. F. Durand, chairman, Dr S W Stratton, Dr. A. F Zahm, Dr H C Dickinson, Dr Herbert Chase and G. C Loening

*Standardization and Investigation of Materials* Dr S W. Stratton, chairman, Dr. Joseph S Ames; Maj-Gen George O Squier, U. S. A, Dr W. F. Durand, Prof J. F. Hayford, Naval Constructor J C Hunsaker, Dr. J. H. Nelson and Dr E D Wales.

*Steel Construction for Aircraft* Dr W. F. Durand, chairman, Dr S W Stratton, Dr A F Zahm, Dr. J. H. Nelson, F G Diffin, W B Stout, Josse Cnats, J W. Smith and H L Whittemore.

*Light Alloys* Dr G K. Burgess, chairman, Naval Constructor J C Hunsaker, C M Manly, E Blough, Z Jeffries and C H Mathewson

## Aircraft Board Against Aeronautical Shows

At the meeting of Dec 4, at Washington, D. C, the new Aircraft Board confirmed the resolution passed by the late Aircraft Production Board on the subject of aircraft expositions, namely, that as a matter of general policy in view of the military situation, it does not encourage the holding of any aircraft expositions for the duration of the war

## S. A. E. Winter Meeting

"The Reasons Behind the Liberty Engine" has been scheduled as one of the leading engineering subjects to be considered by the Society of Automotive Engineers at its Winter meeting in New York on Jan 10

Maj Jesse G Vincent, one of the designers of the engine, will discuss the engineering reasons of the present twelve-cylinder Liberty engine

A special discussion will follow, and will be opened by Lieut-Col. V E Clark, U S A His phase of the discussion will have to do with the military requirements of aviation engines.

Following Colonel Clark, Capt. Howard Marmon, who made an investigation of aviation engineering in Europe some months ago, and who is now engaged in aeronautical engineering work with Major Vincent at Dayton, Ohio, will compare the Liberty engine with European practice

The discussion will be further carried on by H. M. Crane, engineer of the Simplex Co His subject will have to do with adapting European engines to American methods of manufacture

## The Inter-Allied Conference Resolution

The Inter-Allied Conference, which recently convened in Paris, adopted the following resolution dealing with the aircraft programs of the Allies:

"The representatives of the Allied Nations examined the condition of their various war manufactures and considered practical means of avoiding all duplication and directing the effort of each nation to the production of the things for which it was best fitted. In matters of first importance, an interallied committee was formed for carrying out the common programs, and decisions were arrived at"

## DeClerq with Wright-Martin

A E DeClerq has resigned as metallurgical engineer for the Chalmers Motor Co to join the Wright-Martin Aircraft Corp., New Brunswick, N J, in a similar capacity

## C B Rose Called to Washington

C B Rose, vice-president and for many years chief engineer of the Velie Motors Corp., has been called to service in the Inspection Bureau of the Aviation Section at Washington.

## Aeronautical Course at Philadelphia Y. M. C. A.

It has been announced that a free course in aeronautics will be established at the Central Branch, Y. M. C. A., Philadelphia, Pa., as part of the Government plans to train aviators. The course will be under the direction of trained experts and will be confined to teaching the theoretical end of aviation.

## Wesley Joins Wright-Martin

George W. Wesley, who recently resigned as production head of the General Vehicle Co, has joined the Wright-Martin Aircraft Corp in New York His work with the Wright-Martin Corp will also be along production lines

### Bills Pending Before Congress

Among the bills introduced in the first days of the present Congress was joint resolution 112 by Senator Owen of Oklahoma, creating an American Legion of Honor, and authorizing the President to grant decorations to be known as the Cross of Valor, and a decoration or medal for meritorious service, and permitting officers, employes and citizens of the United States to receive and wear decorations tendered to them by any of the nations now engaged in war with the present German Government

Also joint resolution 164, by Representative Lithicum of Maryland, to permit "any soldier, sailor, marine or other person engaged in the service of the United States in the prosecution of the present war against Germany or any of her allies to accept decorations for valor and bravery from any of the nations allied with the United States in the prosecution of said war."

Also by Representative Hulbert of New York, permitting effective and able-bodied women between 18 and 35 years of age to enlist in the military forces of the United States, and providing that they may be commissioned as officers in the Aviation Section of the Signal Corps.

Also by Representative Sinnott, amending the act to provide revenue to defray war expenses so as to exempt military and naval officers and enlisted men from paying the war tax on tickets of admission to places of amusement

Also by Representative Carter of Massachusetts, exempting military and naval officers and enlisted men from the payment of the war tax on railroad tickets.

### Plans of the Civil Aerial Transport Committee

In a recent interview, Dr. W. F. Durand, chairman of the National Advisory Committee for Aeronautics, describes the future and plans of the new Civil Aerial Transport Committee. He said in part

"The future of aviation is of vital importance even at the present time, because upon it depends very largely the future of the thousands of men now going into the air service, the millions or dollars allotted to it by Congress and by industry, and in general, the possibility of salvaging the present investment in aviation expressed in terms of human energy, skilled workmen, trained aviators, time and capital.

"Peace will find this country with an immense air capital on hand. This capital must be so conserved and directed that, if possible, not a man or a dollar will be wasted in the hiatus between war and peace. The situation at the termination of hostilities must be foreseen so far as humanly possible, and plans laid in advance in order that we may then avoid hasty and ill-advised measures

"One of the most important of the many problems pressing for consideration is the human one of what is to become of our airmen. If, when peace comes, a few months are allowed to pass without new business, the industry which has been built up with such care would be seriously crippled. The vast army of workmen required under present conditions will be thrown out of employment and will be forced to seek opportunity elsewhere, thus adding to the industrial confusion which must be anticipated in the readjustment between war and peace.

"One of our problems will be to find means of minimizing the ill effects of such readjustments, possibly by having plans for peace planes for mails, coast guard, policing, and mapping, so up to date that when war orders stop the industry may change over with the minimum disturbance to the more permanent work ahead.

"The first and more obvious use of airplanes in the future lies in the delivery of mails. Already Congress has appropriated $100,000 for the initial steps in aerial mail delivery. The War Department has agreed, subject to Congressional approval, to turn over all planes no longer adaptable to military use to the Post Office as a beginning of its air service. In view of the numbers which may be so transferred later, it is essential to lay plans without delay, as is being done by the Post Office Department, for the specific routes, the aerodromes, quarters, personnel, etc.

"The possible achievements of airplanes in speed and distance seem to be limited only by the imagination. Instances of power and endurance indicate that commercial aviation is so close at hand that its problems must be foreseen. Among them are the 'rules of the air' as compared with the 'rules of the road at sea'; the ownership of the air above private property, questions of police and registration, the right of landing, which was recently denied by an American town, the supply of aerodromes at convenient intervals, the mapping out of air currents, etc. In the international field, questions will arise regarding the collection of customs on airplane freight which may be dropped anywhere within the country from the skies, also questions of 'ports of entry', and the reciprocal use of landing places and aerodromes.

"In addition, extensive plans are already under way for coast guarding by airplanes and mapping the whole United States from the air. Vessels in distress at sea can be located and derelicts destroyed more easily through the air than through a heavy sea. The new coastguard air stations recently authorized by Congress will undoubtedly spring into being as soon as men and planes are available. Likewise, the enormous task of mapping the whole of the United States, now carried out at such expense and under such difficulties, may be much more easily accomplished through the aid of aerial photography. These are some of the problems requiring early consideration."

### Lanzius Aircraft Co.'s New Factory Site

The Lanzius Aircraft Co., 148 Broadway, New York, has acquired for a factory site and flying field a property containing 115 acres in Middletown, Pa.

The factory, it is announced, will be equipped to turn out 1,200 machines a year, and it is expected that equipment will be installed and ready for operation within a few months.

This company has under construction two scout machines, the principle of construction of which being the same as the machine first built by Mr. Lanzius and known as the "Lanzius Variable Angle of Incidence Airplane." The control for changing the angle of incidence is by worm gear, and requires no greater effort than is used in handling other surfaces. These machines will be powered with 8-cylinder Sturtevant 210 hp. engines.

### Eagle Aircraft Co. Organized

The Eagle Aircraft Co., Niles, Ohio, has been organized for the purpose of manufacturing, buying, selling, assembling, repairing, storing, operating, and dealing in airplanes of all kinds and parts thereof and all articles pertaining thereto or to the operation thereof.

Its officers are: H. D. Baker, president; A. J. Engle, vice-president and production manager; G. S. Patterson, secretary and treasurer; directors: C. L. Bartshe, F. C. Case, Joel H. Fuller, Stephen L. Pierce, W. D. Searle, and T. E. Thomas.

### New Process for Plating Aluminum

United Smelting & Aluminum Co., Inc., New Haven, Conn., announces that it has a patented process for electroplating aluminum, which follows closely the standard process of electroplating other metals and from which the same uniform results are obtainable as with other metals.

By this process aluminum may be plated with nickel, silver, copper, etc. The process is said to be equally applicable to pure aluminum in sheets, rods, wire, tubing, etc., and to aluminum alloyed with other metals as in molded or die castings.

### Glenn H. Curtiss Moves to Long Island

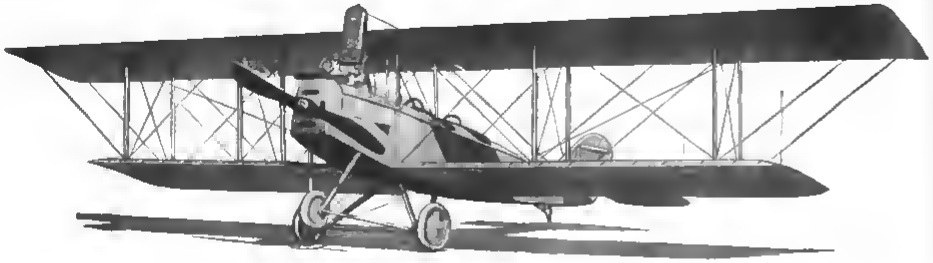
It has been announced that because of the removal of the experimental research and patent departments from the Curtiss Aeroplane & Motor Corp., Buffalo, N. Y., to the Curtiss Engineering Corp., Garden City, N. Y., mail intended for Glenn H. Curtiss and for these departments should be addressed to the Curtiss Engineering Co. at the Garden City address.

### C. D. Pruden Co. Opens New Offices

The C. D. Pruden Co., manufacturer of "Prudential" portable, galvanized steel buildings, underwriters' hollow metal windows, Kalamein doors and windows, with main office and factory in Baltimore, Md., opened on Dec. 1 a general sales office for its products in rooms 806-807 Wallace Building, 56-58 Pine Street, New York City. The office will be in charge of Leigh Pruden, vice-president of the company.

### Fabrig Metal Co.'s New Plant

The Fabrig Metal Co., maker of Fabrig anti-friction metal, which is used for bearings of truck, airplane and other high-grade gasoline engines, has opened another plant which will double the production of Fabrig metal, at 34 Commerce Street, New York.



# Airplane Parts!
## Immediate Delivery!

Fortunately, the present crisis finds the Standard Parts Company ready to help you greatly in the rush demand for airplanes

We are able to ship immediately necessary parts for the construction of airplanes the government must have in a hurry.

You can order from us at once such parts as:

Steel Tubing
Stabilizer Tubes
Push Rod Tubes
Tubing formed per B/P's and straight tubing in diameters ranging from ¼" to 2¾", 14 gauge (.083") to 22 gauge (.028")

Special Rod Assemblies
Rims of all sizes to government specifications
Bearings
Tire Rims
Springs
Forgings.

For years we have made oval and "D" shaped tubing for the Curtiss Airplane Co.

Let us help you make your estimates.

Write us for information at once before you submit your bids for airplane construction.

If you have already made a contract, wire or write us immediately and take advantage of the instant service we can render you.

The factories of this company have been among the foremost in the field of motor-driven vehicles since the earliest days of the industry. Our engineering department and our laboratories are among the most complete in the world.

**The Standard Parts Company, Cleveland, Ohio, U. S. A.**
Famous for Stanweld Rims, Tubing, etc., Perfection Springs, Bock Bearings, Axles, Perfection Heaters, Forgings, Hubs, etc., etc.



# TURNBUCKLES

We Manufacture the Following Type Aeroplane Turnbuckles

### Standard Type

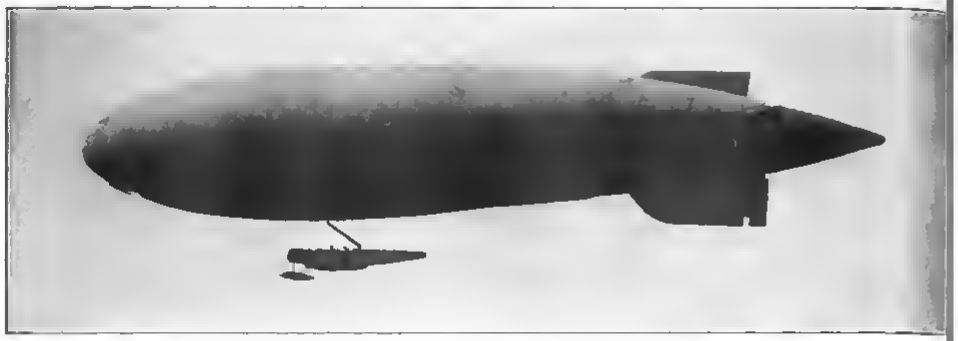
| | | | | | |
|---|---|---|---|---|---|
| No. 1 Female, | Short | A-1518 | No. 2 Female, | Long | A-1520 |
| No. 1 Male, | Short | A-1522 | No. 3 Male, | Long | A-1524 |

### Curtiss Type

| | |
|---|---|
| 326 Short, Male | 327 Long, Female |
| 326 Short, Female | 327 Short, Female |
| 326 Long, Female | 328 Long, Female |
| 327 Long, Male | 329 Long, Female |

## The Dayton Metal Products Company

DAYTON, OHIO, U. S. A.



# D'ORCY'S AIRSHIP MANUAL

**An International Register of Airships, with a Compendiun of the Airahip's Elementary Mechanics**

*By* LADISLAS D'ORCY, M. S. A. E.

*Passed by the Committee on Public Information*

This volume is the result of a methodical investigation extending over a period of four years in the course of which many hundreds of English, French, Italian, German and Spanish publications and periodicals dealing with the present status as well as with the early history of airships have carefully been consulted and digested. It has thus become possible to gather under the cover of a handy reference-book a large amount of hitherto widely scattered information which, having mostly been published in foreign languages, was not immediately available to the English speaking public.

The information thus gathered is herewith presented in two parts; one being a compendium of the elementary principles underlying the construction and operation of airships, the other constituting an exhaustive, but tersely worded register of the world's airshipping which furnishes, whenever available, complete data for every airship of 500 cubic meters and over, that has been laid down since 1834. Smaller airships are listed only if they embody unusual features.

It has been attempted to furnish here the most up-to-date information regarding the gigantic fleet of airships built by Germany since the beginning of the Great War, a feature which may, in a certain measure, repay the reader for the utter lack of data on the Allies' recent airship constructions, which had to be withheld for military reasons. A revised and enlarged edition of *d'Orcy's Airship Manual*, in which all the airships built during the Great War will be listed and their features duly discussed, will be issued upon the termination of the war.

**Oblong, 9½ x 6½ inches. Over 150 illustrations. Price $4.00 Net**

**THE GARDNER, MOFFAT CO., Inc.**

120 WEST 32D STREET NEW YORK CITY



Thomas

THOMAS-MORSE AIRCRAFT CORPORATION

ITHACA, N.Y. U.S.A.

*Contractors to U. S. Government*

Sturtevant

Aeroplane Company

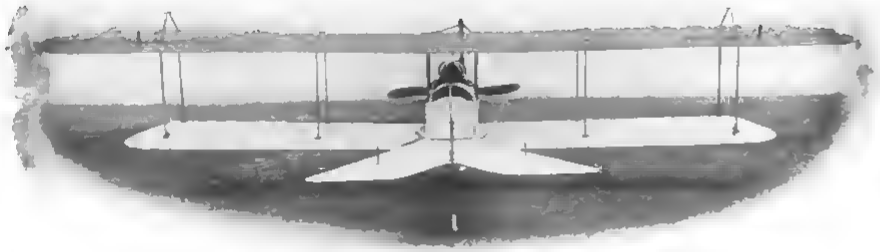
Jamaica Plain Boston

*The*

**Lanzius Variable Speed Aeroplane**

Executive Offices 608-609-610 Singer Building, 149 Broadway, New York City. Telephones 6710-6711 Cortlandt

**Lanzius Aircraft Company**



Model T. T., 90 h. p. Training Tractor

**WITTEMANN-LEWIS AIRCRAFT COMPANY**

Lincoln Highway
Near Passaic River

Newark, N. J.
Telephone Market 9096

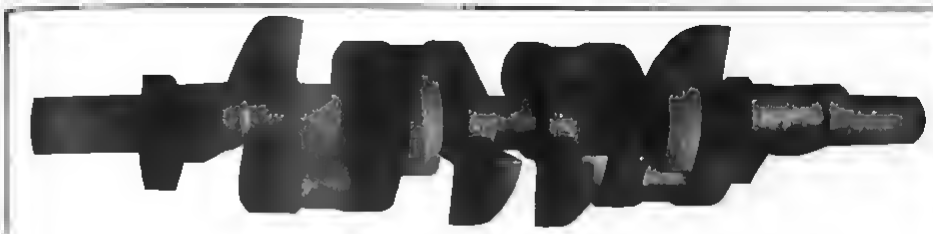
# WALDEN-HINNERS COMPANY

BUILDERS OF AIRCRAFT

MILITARY AIRPLANES
SEAPLANES
FLYING BOATS

OFFICE AND FACTORY
EDGEWATER, N. J.



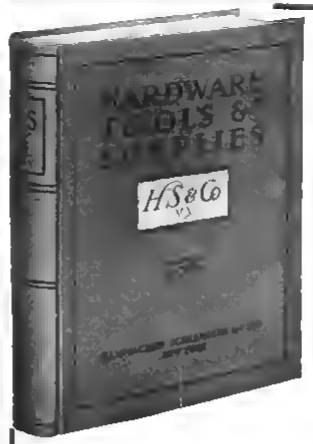


# a counterbalanced aviation crankshaft . . . .

one of the 18 different
models we are now making
for 14 aviation motor companies . . .
reduces vibration and eliminates bearing pressure

*We have shipped 56,938 Counterbalanced Crankshafts to November 26, 1917*

**THE PARK DROP FORGE CO. CLEVELAND, OHIO**




# IT PAYS TO CONCENTRATE YOUR PURCHASES

*IN THIS 1200-PAGE (9 x 12 IN.) CATALOG WE SHOW A COMPLETE LINE OF*

**SMALL TOOLS**
**GENERAL HARDWARE**
**AND SUPPLIES**

It is full of items requisitioned every day in every large factory, many of which are sometimes difficult to locate

If you appreciate the advantages of concentrating your purchases in this line you should write today for a copy of this catalog Please mention catalog No 106

**HAMMACHER, SCHLEMMER & CO.**

NEW YORK, SINCE 1848 Fourth Avenue and 13th Street

# Taft-Peirce is particularly qualified to assist in Aeronautical Development Work

The Taft-Peirce plant is one of the oldest and the most extensive "contract-shops" in the United States. It has been identified with the evolution and initial production of many mechanical developments, each marking a new era in the sphere of human progress—such as the sewing machine, the typesetting machine, the typewriter, the adding machine, the motorcycle and the automobile.

Today it is the largest and best equipped organization of its class in this country for work of the character necessary in the development of aeronautical engines, light machinery parts and special tools.

The advantage of such experience is at the command of concerns whose present production might be materially improved or increased by proper co-ordination

TAFT-PEIRCE
Woonsocket, R.I., U.S.A.

5000

CRANKSHAFTS, Etc., Will Be Put in Running Balance in My Recently Organized

## Laboratory *of* Dynamic Balance

*Centrally Located in This City*

All work guaranteed and done on my latest Balancing Apparatus. It appears that a great deal of misinformation is now being circulated with respect to the would-be *simplicity* with which, for instance, a six throw shaft can be balanced, by some self-appointed *experts*. Let me have a shaft balanced in this manner and I will explain the *correct* way of balancing such a shaft

N. W. AKIMOFF, Builder *of* Dynamic Balancing Machinery

Office HARRISON BUILDING, PHILADELPHIA



# AIR PLANE DRY KILNS

We are prepared to design, equip, install and operate according to Aircraft Engineering Division Specification No. 20,500.

I. *Grand Rapids Vapor Process Kilns* (as perfected thru the erection of 2,000 kilns in high class woodworking plants).

II. *Tiemann Humidity Regulated Kilns* (as designed and developed by the Forest Products Laboratory at Madison, Wisconsin).

III. *Tiemann-Grand Rapids Combination Kilns* (combining the scientific points of the Tiemann kiln with the practical experience of the Grand Rapids Veneer Works, subject to operation by either method).

*We have designed or equipped kilns for*

STANDARD AERO CORPORATION,
THOMAS-MORSE AIRCRAFT CORPORATION,
DAYTON-WRIGHT AIRPLANE COMPANY,
FISHER BODY CORPORATION,
AMERICAN PROPELLER & MFG. COMPANY,
BREESE AIRCRAFT COMPANY
CANADIAN AIRPLANES, LTD

*Our kiln instruments are in use by (in addition to list opposite)*

THE BURGESS COMPANY,
WRIGHT-MARTIN COMPANY,
GLENN L. MARTIN COMPANY
CALIFORNIA AVIATION COMPANY

*Submit your drying problem to experts who make a specialty of kiln design and are prepared to furnish and install all equipment and instruments*

## GRAND RAPIDS VENEER WORKS

Grand Rapids, Michigan Seattle, Washington

# Blackhawk Airplane Company

*Manufacturers of Airplanes and Airplane Parts*

DAVENPORT, IOWA

# "THE TANDEM BIPLANE"

INHERENT LONGITUDINAL STABILITY

Richardson Aeroplane Corporation, Inc.
New Orleans, La.

## Classified Advertising

15 cents a word. Minimum charge $2.00, payable in advance. Address replies to advertisements with box numbers, care of AVIATION AND AERONAUTICAL ENGINEERING, 120 West 32d Street, New York.

LICENSED PILOT, American, first class mechanician with exceptional flying experience desires position as instructor or tester. Willing to conduct experimental work—go anywhere. Address Box 62.

ENGINEER-EXECUTIVE, at present engaged is prepared to undertake the organization of an airplane plant. Equipment, production and operation plans available also staff experienced assistants. Address Box 91.

WANTED—Roberts, Fox Deluxe or Elbridge used engines. State full particulars first letter. M. Wull, Hotel Thomas, Rockland, Mass.

ENGINEER practical and technical, experienced in test, experimental and design aero motors, open for executive position only. Highest credentials. Address Box 77.

WANTED—Head draughtsman for aeroplane draughting room. Also experienced aeronautical draughtsmen and detailers. Only experienced men with highest recommendations need apply. Address Box 90.

LICENSED AVIATOR, with considerable flying experience, both land and water machines, desires position as instructor or demonstrator. Address Box No. 46.



# Aeronautical Trade Directory

AVIATION AND AERONAUTICAL ENGINEERING will furnish information and addresses of all companies listed below. Names of Advertisers in this issue are printed in heavy face type.

**ACETYLENE WELDING AND CUTTING**
Davis-Bournonville Co.
Searchlight Co

**ACCESSORIES AND INSTRUMENTS**
DeVivier Manufg. Co.
Hele-Shaw Motor Co.
Sperry Gyroscope Co.
Standard Aeronautical Co.
Taylor Instrument Companies

**AIRPLANES**
Aeronautic Sales and Engineering Corp.
American Automotive Co.
Automotive Engineering Co.
Bates Aeroplane Co.
Boeing Airplane Co.
Borgess Co., The
California Aviation Co.
Curtiss Aeroplane and Motor Corp.
Dunne Wright Airplane Co
Des Lauriers Aircraft Corp
Emery Aeroplane Co
Fisher Body Corp
Flint Aircraft Co.
Fowler Airplane Corp
Gallaudet Aircraft Corp
Goldrick, The A. S. Corp.
Herrmann, Louis A.
L. B. F. Engineering Co.
Laudau Aircraft Co.
Lawrence-Lewis Aeroplane Co.
Lawson Aircraft Co.
Lewis & Vaught Corp
Loughead Airplane Co.
Michigan Aircraft Corp
Ordnance Eng. Corp.
Richardson Aeroplane Corp., Inc.
Smith Kyle Aircraft Co
Springfield Airplane Co
Standard Aero Corp.
Sturtevant Aeroplane Co.
Thomas-Morse Aircraft Corp
Walden Bianca Co.
Williamson-Lewis Aircraft Co.
Wright-Martin Aircraft Corp.

**AIRPLANE ENGINES**
Aeronautic Plane and Motor Co.
Automotive Engineering Co.
Bourcoselle Motors Corp
Curtiss Aeroplane and Motor Corp.
Deeseberg Motors Corp
General Ordnance Co
General Vehicle Co.
Hall-Scott Motor Car Co.
Hardiman Aircraft Motors Co
Kent Motors Co
Majestic Co.
Miller Barry A. Mfg Co
Orix Motor Co.
Packard Motor Co.
Roberts Motor Mfg Co
Sterling Engine Co
Sturtevant, B. F., Co
Thomas-Morse Aircraft Corp.
Union Gas Engine Co.
Wisconsin Motor Mfg. Co.
World's Motor Co.
Wright-Martin Aircraft Corp.

**AIRPLANE PARTS**
Aut. Aero Sl. of Metal Co
Barnelo Mfg. Co.
Century Telephone Construction Co.
Eric Specialty Co.
Lovell, Walker M. Co.
New Jersey Motor Co.
Pressed Steel Fred. Co.
Rogers Construction Co.
Standard Parts Co.

**ALUMINUM**
Aderal Co., of America
Aluminum Castings Co
Aluminum Co. of America
American Metal Co., Ltd.
Lovgreen & Co.
Meldamite-Aluminum Co.
So-Luminum Mfg & Mng Co.
United Smelting & Aluminum Co.

**AVIATION SCHOOLS**
Atlantic Coast Aeronautical Station
Benson School of Aviation
Curtiss Training Schools
Hydroaeroplane Co.
Michigan State Auto School
Motor Boat & Motor Instructors
Stinson School of Aviation
West Side Y. M. C. A.

**BALL BEARINGS**
Garner Ball Bearing Co.
Hoffman Co., The
New-Bright Mfg. Co
New Departure Mfg. Co.
Norma Company of America.
S. K. F. Ball Bearing Co.
U. S. Ball Bearing Mfg. Co.

**BALLOONS; DIRIGIBLES**
Connecticut Aircraft Co.
Custer Specialty Co. (Stateoscope)
Gas Engineering Co. (Gas Plants)
Goodyear Tire and Rubber Co.
United States Rubber Co.

**BAROGRAPHS AND BAROMETERS**
Green, Henry J.
Haulenbeek A.
Russfield & Lorch
Taylor Instrument Companies

**BEARING METALS**
American Bronze Co.
Fabrig Metal Co
Lovell Walker M. Co.
Myers, J. J

**BUSHINGS**
Boland Brush Oil-Less Bearing Co

**CARBURETORS**
Miller Carburetor Co.
Stromberg Motor Devices Co.
Wheeler and Schebler
Zenith Carburetor Co.

**CLOCKS AND WATCHES**
Chelsea Clock Co
Gepellier, J. & Sep
Waltham Watch Co.

**CLOTHING**
Abercrombie & Fitch
Rogers, Peet & Co.
Saalfeld, C.
Spalding, A. G. & Bros.

**COMPASSES**
Sperry Gyroscope Co.
Taylor Instrument Companies

**DOPE AND VARNISH**
Ademe & Elling Co
American Emaillite Co.
Chemical Products Co.
Conover The C. B. Co.
DePont Chemical Works
Flexible Compound Co.
Herland Wm. & Son
National Aeroplane Co.
Perry-Austen Co.
Pratt & Lambert
Standard Varnish Works
Valentine & Co.
Weeks & Co.

**DRIFT INDICATOR**
Sperry Gyroscope Co.

**DRY KILNS**
Cutler Dry Kiln Co.
Grand Rapids Veneer Works

**DYNAMOMETER**
Sprague Electric Works

**ENGINE PARTS**
Akimoff, N. W
Allegheny Forging Co.
Barnelo Mfg. Co.
Burd High Compression Ring Co.
Daniel, The H. Co.
Doehler Die Casting Co.
Erie Specialty Co.
Fibre Finishing Co.
Gifford-Leland Co.
Gill, F. H. & Sons
Hydraulic Pressed Steel Co.
Lovell, Walker M. Co.
Park Drop Forge Co.
Standard Parts Co.
Taft-Peirce Mfg Co.
Tioga Steel & Iron Co.
Williams, J. H. & Co.
Whitman & Barnes Mfg Co.
Wyman-Gordon Co.

**ENGINEERING**
Automotive Engineering Co.
Ordnance Engineering Co.
White, J. G., Engineering Corp

**FABRICS**
Conrrel Mfg Co
Leach Plotsy B Co.
McBretney Robt. & Co.
Whitman Clarence & Co

**FIRE EXTINGUISHERS**
Pyr-Pyter Co., The
Johns Manville Co., H. W
Pyrene Mfg. Co.

**GAGES**
Boston Auto Gage Co.
Crosby Steam Gage & Valve Co.
Foxboro Co., The, Inc.
United States Gage Co.

**GASKETS**
Fibre Finishing Co.

**GLUE**
Ferdinand, L. W., & Co.
Roeder & Adamson

**GOGGLES**
Strauss & Bingeisen
Strong, Leonard & Noll

**HOISTS**
Yale & Towne Mfg. Co.

**HANGARS**
American Bridge Co.
Ancher Corrugating Constr. Co.
Ashley Steel Bldg. Co.
Austin Co., The
Bowell, Field & Goddard, Inc.
Kenby & Bullivee
Milliken Bros.
Prudrew, C. D. Co.
Virginia Bridge & Iron Co.

**LIFE PRESERVERS**
Universal Safety Mattress Co.

**LUMBER**
Alcock Co., John L.
American Bales Corp.
Chotham Lumber Co.
Delstor, J
Cotton, A. C. Lbr. Corp.
Lodlow, Israel
Rengel, C. C. & Bros. Co.

**LUMINOUS COMPOUND**
Cold Light Mfg. Co.
Cumulous W. L., Chem Co
Radium Dial Co.
Radium Luminous Material Corp.

**MACHINERY, METAL WORKING**
Dalton Mfg. Corp.
Warner & Swasey Co.

**MACHINERY, WOOD WORKING**
Defiance Machine Works
Fox Machine Co.
Machinery Merchants, Inc.
Matthews, C. E., Machine Works
Olney & Warrin

**MANIFOLDS**
Ajax Auto & Aero Sheet Metal Co.

**MAGNETOS**
Bosch Magneto Co.
Berkshire Magneto Corp.
Brisson Mfg. Co.
Remy Electric Co.
Splitdorf Electrical Co.

**METALS**
Aderal Co. of America
American Vanadium Co.
Bethlehem Steel Co.
Detroit Pressed Steel Co.
Federal Pressed Steel Co.
Garland Ventilator Co.
Goeder, Paschen & Frey Co.
Lovell, Walker M. Co.
Myers, J. J
So-Luminum Mfg. Co.

**MODEL AIRPLANES**
Ideal Aeroplane Supply Co.
Wading River Mfg. Co.

**MOTORCYCLES**
Bendee Mfg. Co.

**OILS AND LUBRICANTS**
Baker Castor Oil Co.
Oraphite Lubricant Co.
Golf Refining Co.
Sheppard Diesel Oil Co.
Standard Oil Co.
Swan & Finch
Texas Co
Vacuum Oil Co.

**OIL PUMPS**
Wayne Oil Tank & Pump Co.

**PACKING**
Fibre Finishing Co.

**PHOTOGRAPHY**
Broch, Arthur, Jr.
Herbert & Hoisegen Co

**PISTONS**
Lovett Walker M., Co.

**PISTON RINGS**
American Piston Ring Co.

**PONTOONS**
Niagara Boat Co.
Palmer-Shipley Co. Corp.
Weiss Marine Equipment Co.

**PROPELLERS**
American Propeller & Mfg. Co.
Buffalo Aeroplane Corp.
Doehler, W. Co.
Barriman Aircraft Motors Co.
Neael Walnut Propeller Co.
Lamp Propeller Co.
United States Aero Propeller Co.
West Woodworking Co.

**PYROMETERS**
Foxboro Co., The, Inc.
Shaw Instrument & Mfg. Co.
Taylor Instrument Companies

**RADIATORS**
Ajax Auto & Aero Sheet Metal Co.
Bush Mfg Co.
El Arco Radiators Co.
Engelish & Herelek Co
Flexo Mfg Co
Livingston Radiator Co
Rome-Turney Radiator Co.

**RIVETS**
Simpson, Edwin B., Co.

**SCLEROSCOPE**
Shore Instrument & Mfg Co.

**SHOCK ABSORBERS**
Dural Rubber Corp.
General Rubber Co.
Russell Mfg Co.
Wood, J. W. Elastic Web Co.

**SPARK PLUGS**
Champion Ignition Co.
Johns-Manville Co., H. W
Pyro Ignition Co.
Rajah Auto Supply Co.
Splitdorf Electrical Co.

**SPEED INDICATORS**
Foxboro Co., The, Inc.
Johns-Manville Co., H. W
Stewart Warner Speedometer Corp.

**STABILIZERS**
Grosch Aeronautical Co.
Martin Aerodynamic Stabilizer
Sperry Gyroscope Co.

**STAMPINGS**
Lansing Stamping & Tool Co.

**STARTERS**
Bijur Motor Lighting Co.
Charlestonian, The, Engineering Co.
Cleaver Engineering Laboratories Co.
Motor Compressor Co.
Northeast Electric Co.
Wagner-Buyl Electric Co.

**TACHOMETERS**
Johns-Manville Co., H. W
Nelson Blower & Furnace Co.
Queen-Gray Co.
Stewart Warner Speedometer Corp.
Veeder Mfg. Co.

**TANKS**
Jenney, Steamets & Co.

**THERMOMETERS**
Foxboro Co., The, Inc.
Taylor Instrument Companies

**TIRES AND RUBBER**
Dural Rubber Corporation.
Goodyear Tire & Rubber Co.
United States Rubber Co.

**TOOLS**
Browne & Sharpe
Hall-Scott Motor Car Co.
Hammacher, Schlemmer & Co.
Lansing Stamping & Tool Co.

**TRUCKS AND TRAILERS**
Federal Motor Truck Co.
Four Wheel Drive Auto Co.
Nash Motors Co.
Packard Motor Car Co.
Seebler & Co., The
Service Motor Truck Co.
White Co.

**TUBING**
Bundee Art Metal Co.
Fraser, Peter A., & Co.
Pennsylvania Flexible Metallic Tubing Co.

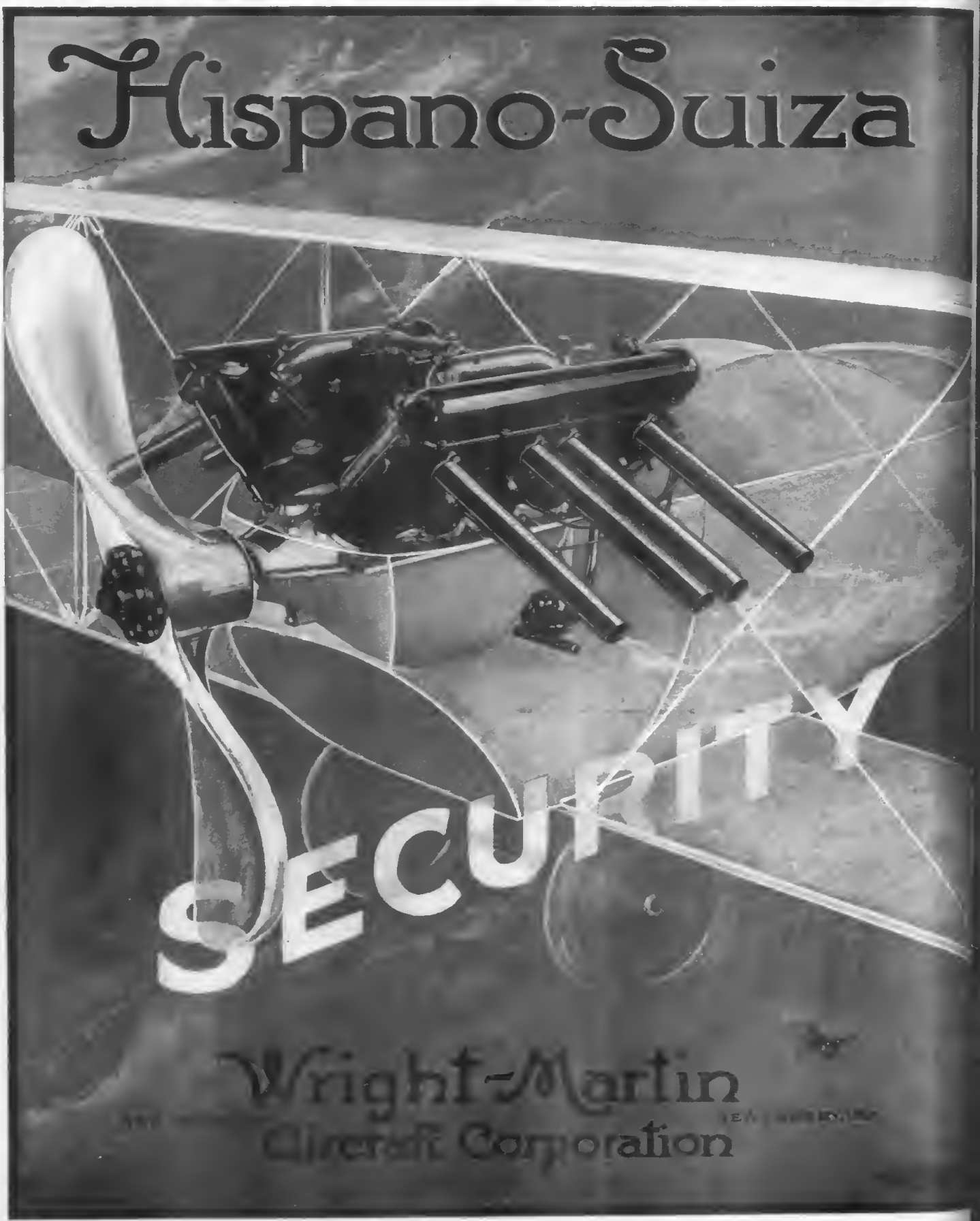
**TURNBUCKLES**
Dayton Metal Products Co.
Eric Specialty Co.
New York & Hagerstown Metal Stamping Co.
Standard Screw Co.

**WHEELS**
Ackerman Wheel Co.
Mott Wheel Works
National Wire Wheel Works
Wire Wheel Corporation of America.

**WIRE**
American Steel and Wire Co.
Century Telephone Construction Co.
Electric Cable Co.
Roebling's, John A., Sons
Simplex Wire and Cable Co.

**WIRELESS**
American Radio & Research Corp.
American Wireless Tel. Co.
Cutting & Washington.

THE WILLIAMS PRINTING COMPANY, NEW YORK


Hispano-Suiza
SECURITY
Wright-Martin
Aircraft Corporation